ARCHIVES of OPHTHALMOLOGY

VOLUME 7 (old series Volume 64) JANUARY, 1932 NUMBER 1

BLINDNESS AND PAPILLEDEMA IN GUERNSEY CALVES, USUALLY BULLS

INCLUDING THE RESULTS OF POSTMORTEM EXAMINATION OF TWO OF THE AFFECTED ANIMALS *

G. E. DE SCHWEINITZ, M.D.

PHILADELPHIA

This communication is concerned with blindness in Guernsey calves with choked disk (papilledema) as the conspicuous ophthalmoscopic feature, based on a personal examination of five animals the subjects of this disease, one in 1916, three in 1930 and one in 1931. Two of the calves were slaughtered, and they furnished the material submitted to pathologic and microscopic investigation. The important literature that directly and indirectly pertains to this disorder is reviewed, and the paper is concluded with remarks on the possible etiologic factors.

Systematic writers, for instance, Bayer [1] and Jakob,[2] in their references to diseases of the optic nerves in animals, included retrobulbar neuritis, optic neuritis (papillitis) and choked disk (papilledema), and the various causes to which they have been attributed.

It appears, quoting Jakob, that intra-ocular inflammation of the nerve head (optic neuritis, papillitis or retinopapillitis) is more commonly present in the horse than in other domestic animals. It has been ascribed, among other etiologic factors, to inflammation of the brain and its membrane, to various types of purulent sinusitis and to certain toxic agents.

According to the same author, simple papilledema has been observed most frequently in horses and dogs and less commonly in other domestic animals, and chiefly in association with encephalitis, leptomeningitis and pachymeningitis, cerebral edema, internal hydrocephalus and tumors; in short, with the lesions that elevate the intracranial pressure.

But admittedly the exact etiology is not always clear, and, as Jakob further pointed out, choked disk as a manifestation of intracranial conditions that increase intracranial pressure occurs far less frequently in animals than it does in human beings, and in such circumstances papilledema is by no means a constant manifestation.

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* Submitted for publication, Sept. 2, 1931.

1. Bayer, Joseph: Handbuch der tierärztlichen Chirurgie und Gebürtshilfe, ed. 2, Vienna, Wilhelm Braumüller, 1906, vol. 5, p. 414.

2. Jakob, Heinrich: Ergebn. d. allg. Path. u. path. Anat. **21**:107, 1927.

Among other lesions to which papilledema in domestic animals has been attributed, Jakob mentioned orbital fracture and tumors, extravasation of blood in the ethmoid and exostoses in the region of the optic foramen.

The cases of choked disk with which this essay is concerned apparently do not belong to any of the types just referred to. Certainly they are unrelated, so far as is now known, to gross intracranial disease. They appear to be a special group, and the precise cause of the optic nerve disorder (papilledema and atrophy) on which the blindness depends has not as yet been discovered.

FREQUENCY

Should one be guided alone by the number of cases of this variety of bovine blindness, to use Nettleship and Hudson's term, that are recorded in the literature, it would appear to be an uncommon disease. However, inquiry among veterinarians reveals that this malady is not exactly a rarity, at least, in the United States. Crocker [3] referred to ten blind Guernsey bull calves in one eastern Pennsylvania herd discovered in 1916 and six in another similarly affected.

Although the account lacks definiteness in this respect, apparently these sixteen calves belong to the group now in consideration.[4]

A personal investigation conducted with the aid of Professor Marshall indicates that the disease has been noted in other herds of Guernsey cattle in Pennsylvania at least three times and that in one herd four animals were affected; also that it has been observed as far west as Seattle and as far south as Texas, and in one herd in Delaware, one in New Jersey and one in Maryland.

Dr. R. E. Shope of the Rockefeller Institute for Medical Research, department of animal pathology at Princeton, N. J., informed me that in one herd near Philadelphia a pair of twin Guernsey bull calves was found to be blind soon after birth, or possibly at birth (no other symptoms). It is likely that the calves belong to this class, but an opportunity to examine them was not afforded.

Nettleship and Hudson [5] stated that this disorder is known to British veterinarians, and is doubtless more prevalent than the literature indicates.

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3. Crocker, W. T.: Cornell Vet. **9**:171, 1919.

4. The records of the Hospital of the School of Medicine of the University of Pennsylvania in 1916 and 1918 refer briefly to ten blind Guernsey bull calves admitted in 1916 and to eight admitted in 1918. These are undoubtedly the same animals to which Crocker makes reference. There is no record of ophthalmoscopic examinations.

5. Nettleship and Hudson: On a Case of Blindness from Optic Neuritis Without Intracranial Disease in a Pedigree Bull, etc., Roy. London Ophth. Hosp. Rep., 1913-1914.

BREEDS AFFECTED AND SEX

All of the affected animals personally examined at the Veterinary Hospital of the University, all others elsewhere in the United States of which I received trustworthy information and five in the pedigree records of Nettleship and Hudson [5] were of the Guernsey breed.

An exception is a red Devon bull calf investigated by MacCallan and Mann [6] and by Summers.[7] However, there is some doubt as to whether this case definitely belongs to the group in question; I was informed by the late Professor Bemis that red Devons are not a pure breed and have a definite Guernsey strain.

Nettleship and Hudson [5] stated: "There is reason to believe that cases of this kind . . . occur in other breeds of cattle." They added, "we do not know to what extent the disease, whether in the Guernsey breed or other, is confined to males." All of the calves in my own list were of the Guernsey breed.

All of the blind animals presumably belonging to this group reported from various portions of the country previously referred to were probably Guernseys and probably males, but it is impossible, in view of the information thus far available, to be sure that this statement is entirely accurate.

I have investigated one blind Guernsey female calf belonging to this group (see appendix), and Dr. Marshall informed me that he has examined (not, however, ophthalmoscopically) four blind female calves in a herd near Philadelphia, and that the veterinarian in charge expressed the opinion that the disease is about equally divided among males and females. However, this statement is not based on expert ocular inspection.

AGE AND ONSET OF BLINDNESS

In four of the animals in the Nettleship and Hudson list blindness appeared at practically the same age, that is, within a month or two of 1 year. In one calf the loss of vision was detected at the age of 2 years.

Blindness was noted in the animal described by Mann, MacCallan and Summers when it was 10 months old. All of the calves personally investigated were under 1 year of age, none younger than 8 months, when the blindness manifested itself, except one that became blind on the fourth day after birth (see appendix).

Crocker, in referring to an experience previously noted, wrote: "Some (of the calves) were born blind, and others, ranging in age from

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6. MacCallan, A. F., and Mann, Ida: Tr. Ophth. Soc. U. Kingdom **46**:229, 1926.

7. Summers, T. C.: Tr. Ophth. Soc. U. Kingdom **46**:221, 1927.

a few days to one year, developed the condition." Unfortunately, there is no record as to whether the calves "born blind" were ophthalmoscopically examined at the time of birth.

GENERAL SYMPTOMS

Except for blindness and its results, symptoms were practically absent in all of these animals. Nettleship and Hudson stated that in none of those in their collection was there any sign referable to the nervous system, unless, they added, "the tendency to walk around in circles, or the habit of making peculiar motions with the tongue should be so regarded."

None of the calves in my group (1916 and 1930) displayed symptoms of anything abnormal except blindness. The calf examined in 1931 (see appendix) was in poor condition owing to diarrhea, which, however, was only temporarily evident.

Crocker stated that the calves he examined exhibited no clinical manifestations of a disordered general condition.

The onset of blindness in most instances appears to have been sudden; that is, it manifested itself abruptly. In one of the calves in Nettleship and Hudson's collection the onset "was believed to be gradual." Sudden loss of vision is also referred to by Crocker, and occurred in all but one of the cases that have come under my observation. In this case, according to the history, for five weeks prior to complete blindness "something wrong with the eye" was noticed. MacCallan and Mann stated that in the animal they investigated the blindness came on gradually.

Nettleship and Hudson suggested that this sudden loss of central vision does not prove that there may not have been a gradual loss of the peripheral visual field, and that the total blindness represents the extinction of the remaining field.

In all of the cases properly examined at the time blindness was complete, the pupils were widely dilated and the iris utterly unresponsive to light, save only in the one case recorded by Mann and MacCallan, who reported that a faint reaction to light was observed.

Ophthalmoscopic examination of two of the bull calves in the pedigree recorded by Nettleship and Hudson revealed no definite changes in the nerve head, although in the one animal that was studied, whose optic nerves were examined microscopically, "optic neuritis was found."[8]

8. In referring to case 1, these authors stated: "Only a partial ophthalmoscopic examination was possible, but although the optic discs were not seen, the retinal vessels that came into view looked normal." In referring to case 2, they said: "Media clear and nothing made out with ophthalmoscope." In referring to cases 4 and 5, they wrote: "There seemed to be no disease of the fundi. The eyes of the bulls were compared carefully with those of a control heifer." The ophthalmoscopic examinations, however, were not made by these authors.

The calf investigated by Mann and MacCallan, and also by Summers, showed disk edema, one hemorrhage near the nerve head and chorioretinitis.

In all of the animals in my own list, choked disk (papilledema) was conspicuous, the disk being elevated from 3 to 3.5 diopters; the veins were enlarged, and there were no other lesions of the fundi. In none of the animals observed here and abroad was there any evidence of external ocular trouble; the media were clear, and in all cases there was no evidence of pain or inflammation.

PROGENY OF THE BLIND BULLS

There is some ground for presuming that this form of blindness is not transmitted to the offspring of the blind bulls, but little evidence with respect to this matter is available. The progeny of two of the bulls in the pedigree recorded by Nettleship and Hudson, so far as these authors could ascertain, were normal in all respects. Crocker wrote that a few of the calves in his list were not destroyed; "they developed, grew fat in the usual manner, although their sight did not improve." But there is no statement as to whether they had progeny. Neither the sires nor the dams in my group were blind.

PATHOLOGIC EXAMINATIONS

CASE 1.—The pedigree recorded by Nettleship and Hudson included six cases, all but one of the same nature; only one of the five animals was examined post mortem. The tissues investigated were: the eyes, the optic nerves, the chiasm, the optic tracts and portions of the brain. The animal was slaughtered three and a half months after the onset of blindness. The specimens were hardened in a solution of formaldehyde, U. S. P. (1:4).

Eyes.—Microscopic examination of the edematous disk revealed marked vacuolation, granular débris, complete disorganization of the nervous tissue and hypernucleation of the supporting tissue. The nerve fiber layer of the retina was degenerated, and there was an almost complete absence of ganglion cells. Weigert's stain demonstrated extensive degeneration of the nerve fibers of the optic nerve, more pronounced in some sections than in others, and a little more marked in the posterior (proximal) than in the anterior (distal) part of the nerve. Hypertrophy of the neuroglia of the supporting tissue was present. The chiasm showed degeneration and proliferation of the neuroglial tissue.

Brain.—There was no evidence of a tumor or of inflammation of the brain and meninges; nothing abnormal was found in the sections of the corpora quadrigemina, the dentate nucleus of the cerebellum or the bulb.

CASE 2.—A Guernsey bull calf from a herd twenty miles west of Philadelphia, 11 months old, with double choked disk, was examined by the late Dr. Reginald Allen and myself in 1916, two days after sudden complete blindness. It was slaughtered one day later, and autopsy was performed by Dr. W. J. Crocker, then associated with the Veterinary Hospital of the University of Pennsylvania, assisted by Dr. Allen. The tissues investigated were: the brain, the optic nerves, the

chiasm and tracts, the lungs and bronchial glands, the heart, the abdominal viscera, the testicles and the voluntary muscles. The specimens were hardened in a 10 per cent solution of formaldehyde.

Dr. Reginald Allen left a full report of the autopsy and of specimens of the various tissues secured at that time for microscopic examination. A condensed description of this record follows: The upper lobe of the right lung apparently was the seat of a pneumonic process. The kidneys were grayish brown and presented a mottled red and yellow surface. The capsule of the liver stripped with difficulty. The spleen was greatly thickened; its cut surface was a deep red and the malpighian corpuscles were revealed as white dots. The duodenum showed a number of small elevations with minute umbilications. The abdominal lymph glands were swollen and translucent. The other organs (thoracic and abdominal) appeared to be normal.

The gross appearances of the brain and meninges were normal; no tumor formation was discovered.

The optic nerve sheath was not distended, but at one place there was a constriction, and at this point a spot of softening to which the sheath was adherent.

Microscopic Examination.—Examination revealed pneumonia of the right lung; granular degeneration of the cells lining the cortex of the kidneys, and many small hemorrhages through the tissue of the organs; vacuolation of the cells of the liver parenchyma, and karyolysis in many of the nuclei; diffuse hyperplasia with blood destruction in the spleen—acute splenitis.

The testicles showed no sign of spermatogenesis, and the testicular acini presented an appearance indicating degeneration which resembled the changes that have been found in the dog's testicles after removal of the pituitary body.

The voluntary muscle tissue exhibited a widespread round cell intercellular infiltration—an interstitial myositis; blood and blood pigment were freely present and everywhere throughout the muscle tissue large numbers of a parasite were found which the late Dr. Allen Smith, professor of pathology and director of the School of Tropical Medicine at the University of Pennsylvania, believed to be sarcocystis, not uncommonly found in cattle.

The optic nerves, optic chiasm and optic tracts, stained by the Marchi method, revealed well marked degeneration. In the "optic nerves,"[9] a great multiplication of neuroglia nuclei was evident.[10]

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9. This term evidently refers to the swollen optic nerve head.

10. Shortly after this research was completed, Dr. Allen joined the army and was killed in action. His original slides could not be found in his laboratories. An imperfect duplicate set was discovered in the Pathological Laboratory of the Veterinary School. Unfortunately, the slides of the optic nerve head and the voluntary muscle tissue are lacking; also the slides of the optic nerve, chiasm and tracts stained by the Marchi method. Six slides of the optic nerve were found stained with hematoxylin and eosin. One of these slides showed an irregular fibroid mass, without signs of specific inflammation, and the blood vessels exhibited no specific change. The others at most revealed separation of the fibers in a form that suggested edema. No infiltration of cells or multiplicity of local cells was present; there was no essential change in the blood vessels. It has not been possible to identify the position of the optic nerve from which these slides were made. As Nettleship and Hudson have pointed out, the degeneration of the nerve fibers is more pronounced in some sections than in others. Dr. Allen was a trained observer, and his statement that with the aid of the Marchi method he found marked degeneration of the optic nerve fibers should be accepted as accurate.

CASE 3.—A red Devon bull calf from a herd in England, examined by MacCallan and Mann,[6] showed complete loss of sight when 8 months old, which had developed gradually (three months). The animal was slaughtered, and a veterinary surgeon reported that all of the internal organs were normal. A microscopic investigation was not made of any of these organs. The left eye was investigated ophthalmoscopically; it showed disk edema (papilledema); at its inner side was a small hemorrhage.

Microscopic Examination.—The disk was swollen (1.5 mm.), owing to vascularization and edema. There was an increase of the nuclei of the connective tissue septums, but no acute inflammation. An area of choroidoretinitis was present on the temporal side of the disk. Except where the retina, choroid and tapetum were fused, the nerve fiber layer, ganglion cells and bipolar nuclei could be made out, indicating that the destructive process emanated from the choroid; no examination of the retrobulbar portion of the optic nerve, chiasm and tracts was made.

CASE 4.—The right eye of the red Devon bull calf described by MacCallan and Mann was examined. Examination of the fundus was made by Summers[7] and Charles Goulden, who noted a swollen disk, all of the edges being blurred as compared with a control bull.

Microscopic Examination.—The disk was swollen about 1 mm., the swelling being due to a great increase of the supporting tissue cells of the nerve head; there was apparently little increased vascularity as shown by the controls. There was a total absence of the retinal ganglion cells, the observation in this respect differing from that of Mann, who found them intact in the left eye of this animal except where the retina, choroid and tapetum were fused.

Sections of the optic nerve behind the globe, stained with hematoxylin and eosin, van Gieson's and Weigert-Pal's methods, were found to consist almost entirely of dense fibrous tissue; nearer the globe than this spot the supporting tissue cells of the nerve showed a marked increase in number; no nerve fibers were seen in any of the sections; areas of choroidoretinitis and fusion of the retina and choroid similar to that reported by MacCallan and Mann were noted.

CASE 5.—A personal investigation was made on three Guernsey bull calves, all under 1 year of age, from a herd near Wilmington, Del. None of them clinically gave evidence of a general malady; all were completely blind, with fixed dilated pupils; the eyegrounds in all of them were exactly similar—papilledema from 3 to 3.5 diopters; the mound swellings were not especially vascular; the retinal veins were enlarged, notably at the disks; there were no visible lesions in the retina, choroid or tapetum.

One of the three calves, 11 months old, was slaughtered; the others were returned to the owner. Autopsy was performed by Dr. E. L. Stubbs and the late Dr. H. E. Bemis of the Veterinary School of the University, at which I was present. Specimens of tissue selected were hardened in a 10 per cent solution of formaldehyde, and all microscopic sections were prepared by Dr. Perce De Long.

Gross Morbid Anatomy.—There was no evidence of disease of the brain, cerebellum or meninges; the bones of the vault of the skull were normal. Nothing abnormal was found in the bones of the orbits or the bony optic canal, or at the base of the skull and the region of the pituitary body.

The middle lobe and part of the apical lobe of each lung were somewhat collapsed, solid and dark. The condition was regarded by the veterinarians as congenital atelectasis, not infrequently found in calves; in some of the bronchi there were collections of purulent material; there was no pleurisy.

The stomach, intestines, liver, spleen, pancreas, kidneys, adrenals and lymph glands were entirely normal in appearance; the muscle tissue revealed no evidence of any disease; parasites were not found.

The eyes, with attached optic nerve, chiasm and optic tracts, were removed intact; no gross abnormality was noted; there was no distention of the sheaths (hydrops).

Microscopic Examination.—Specimens from the middle lobes of the lungs were diagnosed as atelectasis at autopsy. The sections showed insular, peribronchial, septic and fibrinous pneumonitic patches, but no bacteria were demonstrated by Gram's stain. Patches of atelectasis were present. Dr. Herbert Fox detected two uncertain structures suggestive of the remains of parasites.

The liver showed a moderate granular degeneration which Dr. Fox considered as one that might accompany the inflammation of patches in the lungs, but which he did not regard as of importance. A similar opinion was expressed by Dr. De Long, and accords with my own observation.

The spleen and lymph glands revealed nothing of pathologic importance.

The stomach, intestines, pancreas and adrenals were not examined microscopically, but, as before stated, were considered at autopsy to be entirely normal.

The nerve head was increased about two and a half times its normal thickness, and extended laterally 1 mm. over the choroid on each side; the lamina cribrosa was pushed forward to a considerable degree.

The enlargement of the disk chiefly depended on a marked increase of its neuroglia and swelling of the cell bodies present in large numbers. In some sections there appeared to be an edema manifesting itself by a spongy texture caused by the separation of elements. Although the neuroglia was vacuolated to a greater extent than normal, Verhoeff did not regard this as a necessary indication of edema. The blood vessels exhibited little or no alteration, and there was no perivascular infiltration with leukocytes (figs. 1, 2, 3 and 4).

Considerable evidence of destruction existed in the retina; there was marked degeneration of the ganglion cells. No lesions were found in the choroid. The sclera was normal.

Decided atrophy was present in the optic nerve bundles. They were about four fifths of their normal thickness. The sections stained by the Weigert method showed advanced atrophy of the nerve fibers, an atrophy that was present as far as the chiasm, the optic nerve end of which also revealed atrophy, but of less degree than elsewhere. The commissural fibers of the chiasm were not atrophic, and the sections of the optic tracts were not far from normal (figs. 5, 6 and 7).

In none of the slides was there any evidence of inflammation, and the elements concentrated around the blood vessels were glia cells rather than blood elements. Many of the perivascular spaces were distended and filled with fluid and degenerative elements. The blood vessels themselves gave no indication of disease processes.

Specimens from the right hemisphere of the brain were compared with a specimen from an exactly similar area in the brain of a normal bull calf (not a Guernsey) 1 year old. Sections were stained with hematoxylin and eosin and by Weigert's method; the block of tissue was embedded both in paraffin and in celloidin, and the sections were compared with sections from the control bull.

Dr. Winkelman, who studied these slides, was convinced that edema was present as the most prominent lesion. He wrote: "There are numerous vacuoles in the subcortex and marked perivascular spaces of His. A status spongiosus is seen

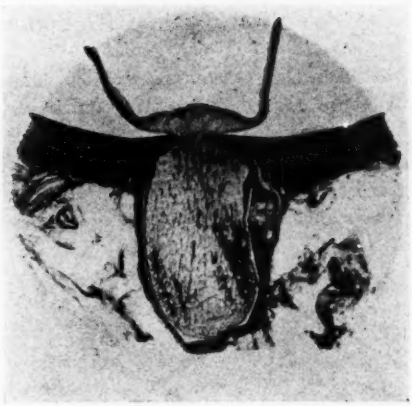

Fig. 1.—Longitudinal section of the nerve head of a blind bull, showing papilledema; there is almost complete atrophy of the optic nerve fibers. Weigert stain.

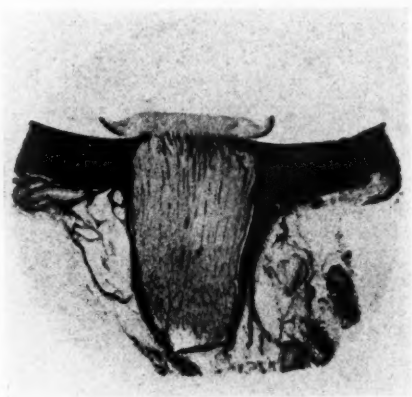

Fig. 2.—Another section of the nerve head of a blind bull, showing papilledema; there is atrophy of the optic nerve fibers. Weigert stain.

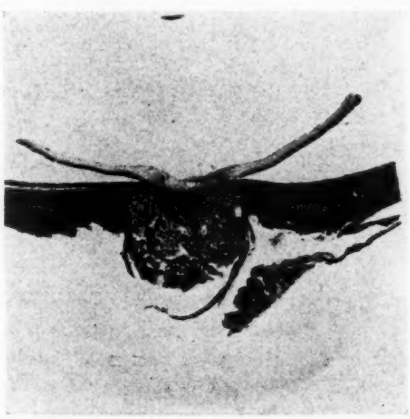

Fig. 3.—Longitudinal section of the nerve head of a normal bull calf. Compare with figures 1 and 2.

around some of the vessels; the ganglionic elements are not disturbed. The Weigert-stained section of the cortex shows no tract anomalies."

Dr. Verhoeff, however, who also investigated all of these slides, was unconvinced that an actual edema such as was described by Winkelman was present; indeed, he definitely stated that: "The sections of the brain show nothing abnormal." And yet a comparison of the sections from the blind bull with those from

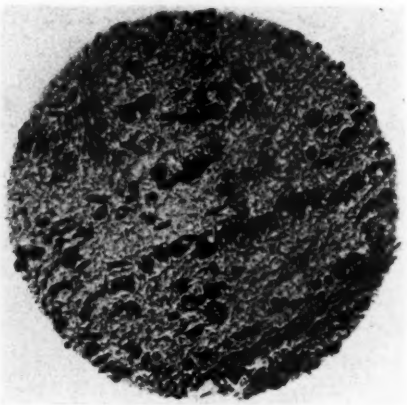

Fig. 4.—Section of the optic nerve head of a blind bull; there is a marked increase of macroglial cells.

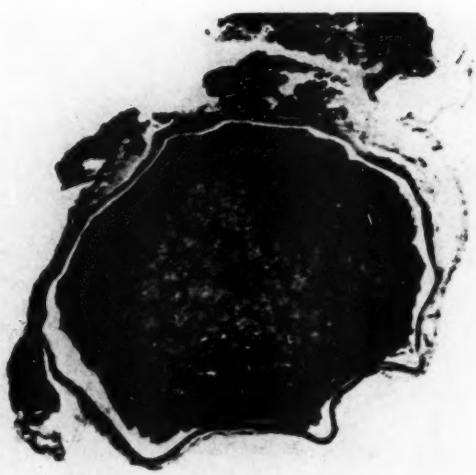

Fig. 5.—Cross-section of the optic nerve of a blind bull; there is atrophy of the myelinated nerve fibers. Weigert stain.

the control bull, as well as the photomicrographs, appear to me to indicate that those from the blind animal reveal conditions not present in the brain of the normal calf. Admittedly, the differences are not great, but equally they are present, and artefacts are excluded by the care with which the sections were prepared (figs. 8 and 9).

Carefully studied sections of the voluntary muscle tissue failed to indicate any evidence of disease; no parasites were found.

Fig. 6.—Another cross-section of the optic nerve of a blind bull; there is less marked atrophy. Weigert stain.

Fig. 7.—Longitudinal section of the optic nerves, chiasm and tracts, showing atrophy except in the crossing fibers. Weigert stain.

Fig. 8.—Section of a specimen from the right hemisphere of the brain of a normal bull calf taken from the area corresponding with that from which the specimen from the blind bull was secured. Celloidin embedding; hematoxylin-eosin stain. Compare with figure 9.

Fig. 9.—Section of a specimen from the right cerebral hemisphere of a blind bull calf, apparently indicating some perivascular edema. Celloidin embedding; hematoxylin-eosin stain. Compare with figure 8.

COMMENT

It appears that there exists among calves, usually, if not exclusively, of the Guernsey breed, a disease characterized by blindness, the onset of which apparently is sudden as a rule and commonly appears within the first year of life. Other symptoms are lacking, general as well as neurologic. The blindness is permanent, and the papilledema, or papillitis, is not caused by gross intracranial disease, such as tumor, encephalitis, meningitis, etc.

Such animals develop naturally, grow fat and, so far as is now known, do not transmit the disorder to their progeny. They seem to belong to a special group, and the disease with which they are affected should probably be regarded as a clinical entity.

From the pathologic standpoint, Nettleship and Hudson advanced the opinion that a toxic agent acting through the blood streams produced a subacute poisoning of unknown origin, which selected the retinas and optic nerves for its activities.

The late Dr. Reginald Allen regarded the widespread parasitic condition of the voluntary muscles as a possible cause of the lesions found in the spleen, kidney, lymph glands and optic nerve. In the only other affected calf examined post mortem in 1930, the voluntary muscles were normal.

As the result of a careful study of my slides, in which on two occasions I participated, Dr. Verhoeff has recorded, at my request, the following opinion:

> I judge that papilledema has existed for a long time, and must have been of high grade, but not sufficient to cause retinal hemorrhages. It has lasted long enough to cause marked proliferation of the neuroglia of the disc, thus converting the disc into a tumor-like mass incapable of shrinking to its original size. The decided atrophy of the optic nerve fibres is in accordance with long duration of the papilledema. The absence of definite edema of the disc indicates that the cause of the choked disc had ceased to act at the time the eye was removed. The absence of any evidences of past or present inflammation indicates that the cause of the papilledema was increased intracranial pressure, probably not of high degree but of long duration. The possibility, however, that the papilledema was due to preexistent slight inflammation of the nerve with marked edema, is not positively excluded.

MacCallan and Mann regarded the whole process in the eye that they examined as the result of a slow, chronic blood-borne infection. It is doubtful if this case belongs to the group now under discussion, as these authors pointed out, referring especially to Nettleship and Hudson's pathologic observations from which theirs differ considerably.

Summers, who studied the right eye of the same animal, considered the condition found to be one "due to retrobulbar neuritis and choroidoretinitis . . . with the initial focus probably . . . in the region

of the block of fibrous tissue in the nerve," where also masses of leukocytes were found.[11] To him, the severity of the changes suggested a bacterial origin.

POSSIBLE ETIOLOGIC FACTORS

Food Poisoning.—Nettleship and Hudson, commenting on the fact that in two of their animals belonging to the same herd the blindness came on at the same time to a day, expressed the opinion that this event points strongly to "something wrong with the dietary," but they were unable to advance evidence in proof of the validity of this suggestion.

Crocker excluded food poisoning as an etiologic factor. A "patent" food product that had been suspected of deleterious influence was tried, but failed to produce visual disturbance, and this was true of other rations—moldy alfalfa ensilage and moldy corn. He concluded, however, as the result of an investigation of a blind Guernsey bull calf, belonging to the group referred to in footnote 4, that the blindness should be ascribed to "insidious rachitis due to disturbance in metabolism of minerals, especially lime salts, following over-feeding of dams with highly nutrient food-stuffs, resulting in rachitic deformation of the sphenoid bone of the foetus, stenosis of the optic foramen or canal, chronic fibrous optic neuritis and pressure atrophy."

I am unacquainted with any other similar record. Certainly nothing of the kind was demonstrable at the autopsy of the blind bull that I have described, at which the bones of the orbit, the sphenoid and ethmoid gave no evidence of disease; nor is there any record in Reginald Allen's report of his finding of such lesions.[12]

J. R. Mohler, chief of the Bureau of Animal Industry at Washington, D. C., wrote to Professor Klein: "In regard to grain feeding causing blindness in cattle, it has been demonstrated repeatedly that heavy feeding upon cotton-seed meal is quite prone to result in total loss of vision."

In referring to this statement, Professor Klein pointed out that one variety of this blindness is due to an inflammatory or infective process with clouding of the cornea, etc., and therefore a type of disease with which this discussion is not concerned.

Naturally, however, this does not imply that food poisoning may not cause other forms of blindness. Therefore, of considerable interest

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11. A similar mass of fibrous tissue similarly situated was found by Dr. Allen and by Crocker.

12. It is proper to mention, however, that there is no definite statement in Allen's report that the orbital bones or bony structures of the sinuses were healthy. He referred to a constriction of the optic nerve at one place, but did not indicate at what portion of the nerve this constriction was found. As Crocker performed this autopsy, Allen assisting, it is unlikely that any bone disease would have escaped their attention.

with respect to this matter is a research by Delez.[13] The animals (thirty) with which he experimented ranged in age from birth to 2 years. Blindness occurred in twelve of the calves fed on rations of corn-distiller's grain, corn gluten, cotton-seed meal and wheat straw, and for two months alfalfa hay and corn silage were added to the rations. There is no record of an ophthalmoscopic examination of these animals.

In one case microscopic examinations of sections of the optic nerves revealed decided degeneration of the central portion of the nerve, with disintegration of the myelin sheaths, that is, an axial degeneration.

In another case, a marked contraction of the optic nerve trunk was found (3 mm. long and 1.5 mm. wide), with atrophy of the fibers at the point of this contraction.[14]

Obviously, should Delez' observations be confirmed, definite proof would be available that food poisoning is capable of producing blindness and optic nerve degeneration in cattle, not necessarily, however, of the type described in this essay.

Family Papilledema or Papillitis and Inbreeding.—The five bulls in the pedigree reported by Nettleship and Hudson were all related to each other more or less closely by blood, a fact that these authors stated "arouses the suspicion that the disease of the optic nerves . . . was the result of an hereditary disposition analogous to the well-known family optic neuritis of the young adult human male." Dr. De Long recorded a similar suggestion in his report.

As is well known, hereditary optic neuritis or optic nerve atrophy (Leber's disease) may appear for a number of generations, usually, but not always, in male members of the family, and is generally transmitted by unaffected females.

So far as I know, none of the blind bulls transmitted the disease to their progeny, but the evidence in this respect is definitely imperfect.[15]

The first bull that Allen and I examined in 1916, and the bulls admitted to the Hospital of the Veterinary School of the University in 1916 and 1918, all came from the same herd and all belonged to a famous Guernsey family. Like those described in the pedigree recorded by Nettleship and Hudson, they probably were "related to each other

13. Delez, A. L.: Pathological Alterations Observed in Cattle Fed on Special Rations, J. Am. Vet. A. **74**:227 (Jan.) 1929. This article is an abstract of a thesis presented to the faculty of the Michigan State College, and was received for publication on June 9, 1928.

14. This observation is similar to the one made by Reginald Allen and T. C. Summers.

15. Crocker stated that the sires of some of the calves that he described had actinomycosis, but none of their progeny was thus affected. The dam of one of the bulls, investigated by me in 1930, "had lump jaw" (actinomycosis), but was otherwise normal.

more or less closely by blood." The three calves investigated by me in 1930 were the progeny of two bulls. One of them (the one fully described in the text) was a typical product of inbreeding.

Inbreeding, it would seem, should be regarded as one definite predisposing factor in the development of this form of bovine blindness. Indeed, Sir John Parsons, in his discussion of Summers' case, stressed this point.

Perhaps another factor should be taken into consideration, namely, a congenital inferiority, or an abiotrophy of the optic nerve apparatus, which caused premature death or decay of its tissues.

CONCLUSION

Although the onset of blindness in most of the cases has been sudden, this sudden loss of sight should be regarded as the final stage of visual degradation caused by a process that had been developing gradually for a considerable period of time. Moreover, some of those calves were born blind, or else the blindness appeared only a few days after birth, in one of my cases (see appendix) on the fourth day. Therefore. it may well be that in some instances at least the lesions of this disease have their beginning in prenatal life.

Although food poisoning, according to Delez, may be responsible for an axial degeneration of the optic nerve, I question whether it should be regarded as the efficient cause of the particular variety of blindness with which this essay is concerned. His interesting research should be repeated and the missing links in his chain of evidence supplied.

It may well be that a toxemia elaborated by the parasites that crowded the voluntary muscles of the bull that Allen investigated caused the lesions he found in the kidney, liver, spleen and lymph glands. But it is only reasonable to regard the parasitic condition and toxemia as incidental in an animal predisposed to degeneration of the optic nerve apparatus, and not as an essential etiologic factor.

One cannot escape the conviction that this form of bovine blindness is a special or familial disease that depends largely on inbreeding, which predisposes the animal to its salient manifestations: permanent blindness due to choked disk (papilledema or papillitis), developing gradually, and ultimately destruction of the ganglion cells of the retina and extensive degeneration of the optic nerve apparatus as far as and including the chiasm.

APPENDIX

Shortly after the completion of this paper, a female Guernsey calf was sent to the Veterinary Hospital of the University of Pennsylvania from the same herd and family from which the original bull calf came.

arriving too late to be included in the group described in the main body of this essay.

Defective vision was noticed on the fourth day after the animal's birth, and when examined by Dr. Marshall and by me one day later, the calf appeared to be quite blind. The pupils were widely dilated and unresponsive to a strong light that was flashed into its eyes.

The appearances of the eyeground were normal, except that the veins were greatly dilated. Papilledema in the sense of a definite elevation of the disk was not present, but covering the center of each nerve head was a layer of finely spun, pinkish-gray material, extending slightly beyond the margins. This layer was semitranslucent, and the blood vessels of the disk were readily seen. I have not previously observed a condition exactly of this character and am not sure of its interpretation. It probably represents the early stage of papilledema.

The calf is still under observation and shall so remain, affording an opportunity of watching additional nerve head changes, should they occur. It is probable that the calf was born blind, although the loss of vision was not noticed until the fourth day, thus confirming an observation by Crocker previously reported.

The following members of the faculty of the School of Veterinary Medicine of the University of Pennsylvania helped me in this research: Dr. Louis A. Klein, Dr. Clarence J. Marshall, the late Dr. Harold E. Bemis and Dr. Evan L. Stubbs.

The late Dr. Reginald Allen of the Department of Neuropathology of the School of Medicine of the University of Pennsylvania prepared the microscopic slides of tissues selected from the bull calf slaughtered in 1916 and reported his interpretations of these specimens. Dr. Perce De Long, Assistant Professor of Ophthalmology at the Graduate School of Medicine of the University and my laboratory associate, prepared a microscopic study of the material obtained at the autopsy of one of the three calves investigated in 1930, and reported his observations.

Dr. Herbert Fox, Professor of Comparative Pathology at the University of Pennsylvania, Dr. Nathaniel W. Winkelman, Professor of Neuropathology at the Graduate School of Medicine of the University, and Dr. F. H. Verhoeff of the Harvard Medical School assisted in studying these slides and recorded their interpretations.

THE MILD FORM OF EPITHELIAL DYSTROPHY OF THE CORNEA *

SANFORD R. GIFFORD, M.D.
CHICAGO

The picture of epithelial dystrophy as described by Fuchs [1] is so characteristic that it could hardly fail to be recognized by any one having the condition in mind. Little has been added to his classic description of the condition given in 1910. In its essentials, the condition consists in an edema of the corneal epithelium with the formation of numerous blebs of varying size, associated with punctate grayish opacities in the epithelium and grayish lines and dots in the parenchyma. The condition begins insidiously, the only symptom being gradual diminution of vision, which was reduced to 6/60 or even counting fingers in most of Fuchs' cases. The sensation of the cornea is greatly diminished or absent, and Fuchs believed the cause of the condition to be a disturbance of nutrition affecting the superficial corneal nerves. All of his patients were over 48 years of age, and nine women were affected as against four men. Treatment was of practically no effect in his cases, removal of the epithelium being followed by only temporary improvement. In five of his cases the condition was bilateral and in five unilateral, while in three other bilateral cases an increase of tension developed. Nineteen cases collected from the literature in 1925 since Fuchs' report bore out his description in almost all particulars. Eleven were in women and only six in men. Nine were bilateral and five unilateral. Four showed definite glaucoma and several others temporary attacks of hypertension. All but two patients were over 50 years of age. The cases reported from this country were those of de Schweinitz, Whitham, Reese, Arnold Knapp, Uribe Troncoso and the Friedenwalds. But the condition is not as rare as would appear from this, since Whitham saw three, the Friedenwalds noted three and I have seen at least four typical cases. The principal additions to the description of Fuchs have been those afforded by the slit-lamp, as described by Kraupa and Vogt, Whitham, Merigot de Treigny, the Friedenwalds and in my previous report. It was noted that the entire epithelium was edematous in these cases, showing grayish opacities as well as blebs. Deeper striate opacities and

* Submitted for publication, July 10, 1931.

* From the Department of Ophthalmology, Northwestern University Medical School.

1. Fuchs: Arch. f. Ophth. **76**:478, 1910.

folds in Descemet's membrane were also present. Kraupa and Vogt and the Friedenwalds first called attention to the presence of endothelial deposits exactly like those seen in the endothelial dystrophy described by Graves. The Friedenwalds saw these in one case at a time when no epithelial changes were present, the patient later developing typical epithelial dystrophy. They concluded that the endothelial change is an essential part of the picture, in fact the primary condition, the epithelial change being secondary. Vogt saw an early case of Fuchs' dystrophy with well marked endothelial deposits. He thought that such hyaline deposits could well be the cause of epithelial dystrophy by causing degeneration of the endothelium and allowing aqueous to penetrate the cornea. In my previous report the endothelial changes were seen in two typical cases, while in a third advanced case they were absent. In the mild cases to be described, they were present in only three instances, and this, with their absence in one typical case, makes it seem unlikely that they can be the primary condition in this form of dystrophy. These endothelial deposits, resembling clear dew-drops on the endothelium and arranged in a regular pattern over the cornea, are recognized to be hyaline material formed as excrescences on Descemet's membrane, and of the same nature as Henle's warts of the lamina vitrea. They are known to be a not uncommon senile or presenile change, and their occurrence in eyes with epithelial dystrophy might be a coincidence. It is quite possible, however, that eyes with the nutritional disturbance that seems to be present in epithelial dystrophy may be also predisposed to the formation of these hyaline excrescences. Henle's warts of the lamina vitrea are known to be larger and more numerous in diseased eyes, especially eyes with hypotony, and phthisis bulbi, and the abnormally low tension found in many cases of epithelial dystrophy may be a factor in the formation of endothelial deposits.

The typical picture of epithelial dystrophy can be confused with but few conditions. In advanced or absolute glaucoma the cornea often shows changes that are identical, and it is quite possible that in some of the reported cases in which glaucoma occurred this was the primary condition, the corneal changes being secondary to increased tension. In the typical condition I have found the tension abnormally low (7 mm. Schiötz in each eye in one case, 12 mm. in each eye in another and 10 and 12 mm., respectively, in a third). Changes in the cornea following the cataract operation, as described by Knapp, de Schweinitz and others, may produce exactly the same picture. Fuchs recognized this, believing that the changes resulted from damage to the corneal nerves by the section, and he separated these cases from his group of primary dystrophies. The changes in neuroparalytic keratitis may also greatly resemble this condition, although they more often resemble the mild form to be described.

While the typical condition only occurs once in about 20,000 cases, according to Fuchs, the mild form of epithelial dystrophy, which it is the real purpose of this paper to describe, occurs much more commonly. I have seen at least thirty such cases and believe that they are often overlooked, especially if slit-lamp examination of the cornea, after staining with fluorescein, is omitted.

The accompanying table summarizes the findings in twenty-three cases of this mild form of dystrophy and three of typical epithelial dystrophy not included in previous reports. In a number of other cases the records could not be found or the findings were insufficiently recorded. Included with these cases are those of two patients with acne rosacea, which may belong in a special group. The corneal changes, however, were identical with those in other cases of the mild form of dystrophy. I am indebted to Dr. Norah M. Fairchild for bringing in several of these patients from the University of Nebraska Dispensary for slit-lamp examination and for her notes on case 26.

The usual history in the mild form is of a scratchy feeling in the eyes with some diminution in vision. There is seldom any real pain, and vision is apt to be worse in the morning, clearing up later and often being practically normal for the greater part of the day. One eye is usually affected more than the other, and often a decrease in vision is noted only in one eye. This decrease is seldom extreme, vision varying from 20/30 to 20/50 in cases of average severity, and in milder cases vision is practically normal at most examinations. The age of the patients varies, but most are in middle life or older. In my series the average age was 49, the oldest patient being 72, and only one, a man of 29, being younger than 35. Fifteen patients were women and seven men. The cases of typical dystrophy all occurred in women. On ordinary examination few objective signs are to be seen. There is often slight superficial congestion, but there may be none at all. Examination with focal illumination may show a slight dulness of the window reflex, which with the loupe may be resolved into a slight roughening of the corneal epithelium. Ophthalmoscopic examination with the dilated pupil and a plus 10 diopter sphere before the ophthalmoscope will often show a number of fine black dots against the red reflex, which, when one is familiar with the condition, may at once lead to the diagnosis. In many mild cases, however, nothing is seen with the ophthalmoscope. A moderate degree of chronic catarrhal conjunctivitis and blepharitis is often present. Such patients, especially those in whom the visual defect is inconsiderable at the time of examination, may be considered as simply sufferers from eye strain. They have often been refracted, frequently without obtaining benefit from the changes made in the correction, or have been given treatment for the lids.

Cases of Typical Epithelial Dystrophy (Fuchs) and the Mild Form of Epithelial Dystrophy

Case	Patient	Age	Tension	Sensitivity	Vision	Time of Observation	Results	Comment
				Typical Epithelial Dystrophy				
1	Mrs. Mi....	57	R 10 L 12	Much reduced	R 20/100 L 20/50	1 visit	.....	Deep opacities; typical Fuchs' dystrophy
2	Mrs. Mas...	61	Not taken	Not taken	R 20/30 L 6/200	5 yrs.	Condition became worse	Typical Fuchs' dystrophy with endothelial deposits
3	Mrs. Ab....	50	Not taken	Not taken	R 3/200 L 20/20	Few days	....	Original injury of right eye; condition of this eye resembled Fuchs' dystrophy, but left eye was normal (not a primary dystrophy)
				The Mild Form of Epithelial Dystrophy				
4	Mrs. Ko....	50	Not taken	Not taken	R 20/40 L 20/50	10 mo.	Recurrences	.....
5	Mrs. Pa....	48	Not taken	Not tried	R 20/20 L 20/20	1 mo.	Symptoms improved on ethylmorphine hydrochloride	.....
6	Mrs. Wr....	72	R 12 L 17	Decreased	R 20/20 L 20/30	4 yrs.	Improved on ethylmorphine hydrochloride; thyroid therapy	Hypothyroidism; chronic conjunctivitis
7	Mrs. Gr....	68	Not taken	Some insensitive areas	R 20/30 L 20/70	10 mo.	Improved on ethylmorphine hydrochloride; recurred	Lens opacities
8	Miss Cr....	41	Not taken	Not tried	R 20/15 L 20/20	3 mo.	Cleared up on ethylmorphine hydrochloride	Endothelial deposits
9	Mr. Os.....	29	Not taken	Not tried	R 20/15 L 20/20	1 yr.	Cleared up on ethylmorphine hydrochloride	Only one eye affected
10	Mrs. Sh....	38	Not taken	Not tried	R 20/30 L 20/20	3 yrs.	Corneal staining cleared up; symptoms continued	.....
11	Mr. Bo.....	48	R 7 L 7	Not tried	R 20/30 L 20/20	Seen once	.....	.....
12	Mr. F. Ed..	51	Not tried	Right eye: anesthesia in center; left: normal	L 20/20 L 20/200	2 yrs.	Improved; recurred	Deep opacities of left eye; right eye normal
13	Mr. Hu.....	54	R 13 L 9	Reduced	R 20/80 L 20/40	1 wk.	Not followed	Blepharitis
14	Mrs. Hub..	40	Not tried	Not tried	R 20/30 L 20/30	1 yr.	Vision decreased to 20/70 (R)	Had Raynaud's disease and acne rosacea
15	Mr. Wl.....	45	R 11 L 14	Not tried	R 20/20 L 20/20	1½ yr.	No improvement	.....
16	Mr. Ut.....	60	R .. L 24	Not tried	R 20/15 L 20/15	2 mo.	Symptoms improved on phenacaine	.....
17	Mrs. Dw....	69	R 18 L 23	Not tried	R 20/20 L 20/20	1 mo.	Improved on ethylmorphine hydrochloride	.....
18	Mrs. Mar...	65	R 9 L 9	About normal	R 20/25 L 20/25	1 mo.	.....	Had endothelial deposits and deeper lines in stroma

Cases of Typical Epithelial Dystrophy (Fuchs) and the Mild form of Epithelial Dystrophy—Continued

Case	Patient	Age	Tension	Sensitivity	Vision	Time of Observation	Results	Comment
19	Mrs. De....	50	R 12 L 10	Not tried	R 20/15 L 20/15	3 yrs.	Improved on phenacaine; no staining at times; recurred many times	Some blepharitis
20	Mrs. Qu....	35	Not tried	Not tried	R 20/40 L 20/15	6 mo.	Vision improved to 20/20 (R)	More conjunctivitis; not typical case
21	Mrs. Sa....	49	R 13 L 14	Slightly reduced	R 20/40 L 20/30	1 mo.	Improved	Has acne rosacea
22	Mrs. Tw....	49	Not recorded	Not tried	R 20/20 L 20/30–1	Seen once	.....	Endothelial deposits (Graves)
23	Mrs. Man..	44	R 13 L 13	.....	R 20/20 L 20/50	2½ yrs.	Vision improved to 20/20 each eye; cornea still stains	Pruritis since menopause
24	Miss Jo....	46	Not tried	Not tried	R 20/30 L 20/30	2 yrs.	Cleared up on ethylmorphine hydrochloride; no staining	.....
25	Mrs. McC..	61	R 15 L 10	About normal	R 20/20 L 20/20	1½ mo.	Symptoms improved on phenacaine	Blepharitis
26	Mr. Pe.....	42	R 14 L 14	Complete anesthesia in central regions	R 20/50 L 20/50	1 yr.	Vision improved to 20/30 in each eye	(Dr. F.)

Examination with the slit-lamp, after the instillation of 1 per cent fluorescein, shows changes that make a diagnosis unavoidable in even the mildest cases. A number of areas that stain with fluorescein are seen, which vary in number from five or six to several hundred. Minute blebs may be present, but more often it is only the remains of ruptured blebs, the staining areas, which are seen. These areas are usually more numerous just below the center, but may be found all over the cornea. Between such areas, and usually involving the whole corneal epithelium, tiny droplets are present, which are best seen with retro-illumination, the beam being focused on the iris while the cornea over this is examined with the microscope. The droplets are so small as to be distinct only with the higher magnifications of the microscope. They represent an edema of the epithelium that is always present, the droplets collecting, apparently, between the epithelial cells and forming in certain places tiny blebs, which promptly rupture and leave staining areas from five to twenty times as large as the droplets. They may be so large as to be seen with the loupe, but are never to be confused with the larger blebs occurring in recurrent erosion of the cornea, and the pain associated with their formation in the latter condition is entirely absent. Besides edema of the epithelium and staining areas, which are constant, many cases show fine punctate white dots in the epithelium which do not stain and which seem to represent the site of former blebs. The corneal nerves are often definitely enlarged, but such nerves may

show no particular relation to the opacities. Opacities in the corneal stroma are only occasionally seen, in more severe cases.

It is probable that all stages occur between the mild forms described and the typical dystrophy of Fuchs. Fuchs mentioned one mild case in his series, with vision of 5/8 and 5/6, in which the condition remained the same for six years. I have never seen the mild form progress to the severe form, and some cases observed for three to four years showed no definite changes suggesting such a progressive process. These

Fig. 1.—Appearance of corneal epithelium in a case of the mild form of epithelial dystrophy, seen by diffuse light under a magnification of 1:80. (The defects are not so distinct as shown unless stained with fluorescein.)

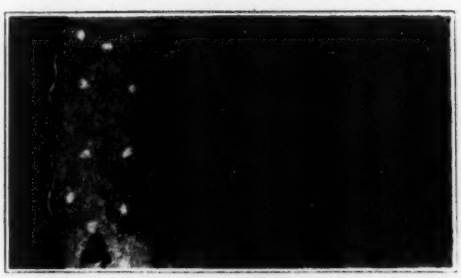

Fig. 2.—Appearance of corneal epithelium in the same case as seen in the focal light of the narrow slit-lamp beam (*A*) and by light reflected from the iris (*B*). In *B* the fine droplets of epithelial edema can be seen.

cases showed rather periods of more or less quiescence with intermittent exacerbations of the condition. Case 18, showing endothelial deposits, deeper linear opacities in the stroma and a tension of 9 mm. Schiötz in each eye, represents an intermediate stage, vision being reduced only slightly, to 20/25 in each eye. Cases 7 and 22, in which endothelial deposits were present, may also represent intermediate stages. In case 12, deep opacities were present in the only eye affected, and the

vision, 20/200, was as much reduced as in some cases of typical dystrophy. It seems likely that cases of typical form, if seen very early, would show a picture like that of the mild form, and such early stages have, no doubt, been frequently overlooked. The Friedenwalds' case in which the endothelial changes were present alone and the typical condition developed later opens, of course, the possibility that the presence or absence of these changes indicates which cases will go on to the typical condition. This cannot be stated until the course of more cases has been observed with the slit-lamp. The fact that these changes have not been described in most of the reported cases of typical dystrophy is no evidence that they were not present, since most of these cases date from the pre-slit-lamp era. The fact that they were absent in one of my cases and were noted only in the cases of the Friedenwalds, Kraupa and Vogt, however, make it impossible to state that they are an essential element of the condition.

An almost constant finding in the mild form of epithelial dystrophy, as well as the typical form, is more or less marked insensitivity of the cornea. When tested with a tightly wound cotton wisp, cut off with scissors so that what remains is fairly stiff, most patients feel no sensation of pain, and do not wink when touched. The frequency of this decreased sensitivity is not well shown in the table, as no record of the test was made in a number of cases showing it definitely. This condition is most marked in the center of the cornea, but the sensitivity of the whole cornea is reduced. The degree of decreased sensitivity varies considerably, and in a few cases it could not be considered abnormal. Without the systematic use of Frey's hairs, with which measured degrees of pressure may be exerted, it cannot be said that an abnormally decreased sensitivity is always present in the mild form of dystrophy, since the normal corneal sensitivity is known to vary considerably. Pflimlin, using Frey's hairs, found that 10 per cent of normal persons show a reduced sensitivity of the cornea, as compared with what he found was normal. Persons subject to recurrent corneal herpes, he found, belonged in this group, since the unaffected cornea as well as the one affected always showed reduced sensitivity. He considered that such an insensitivity, which was recorded in several members of three families, offers the predisposing cause of recurrent herpes, the actual attack of herpes being brought on by the presence of the herpes virus. While there is nothing in common between recurrent corneal herpes and epithelial dystrophy except the corneal insensitivity, it is a fact that when one eye is predominantly affected by the dystrophy, the other cornea nearly always shows reduced corneal sensitivity. It usually shows as well some edema of the epithelium and a few minute staining areas. In other words, it is nearly always affected

by a very mild degree of dystrophy. In only two of my cases was one eye found to be completely normal.

Another interesting analogy is that between corneal dystrophy and neuroparalytic keratitis. Any patient who has undergone trifacial neurectomy, when looked at with the slit-lamp corneal microscope after staining with fluorescein, even when the cornea appears perfectly normal to ordinary examinations, shows a picture almost identical with the mild form of epithelial dystrophy. There are present a generalized edema of the epithelium, a varying number of minute staining areas and, of course, complete anesthesia. The corneal nerves are often enlarged in both conditions. Thus it seems that the presence of reduced corneal sensitivity is more than an incident in epithelial dystrophy, and it is quite likely that the mild as well as the typical form may be due primarily, as Fuchs suggested, to a degeneration of the corneal nerves or their end-bodies. An investigation of a number of normal corneas with Frey's hairs and examination of those showing reduced sensitivity with the slit-lamp would be of interest in this connection, and might show in such corneas some degree of edema of the epithelium and perhaps abnormalities in the retention of fluorescein. It would also be interesting to know if the corneal sensitivity is reduced in old age, since the condition may well be a degeneration of the corneal epithelium as part of a generalized senile or presenile change in the epithelium.

It is important, of course, that no cocaine be used in examination of the cornea, since the use of even 2 per cent cocaine produces a definite edema of the epithelium and causes certain areas to retain the stains. Fluorescein and rose bengal are the stains most suitable for such examination, since some of the other stains, such as methylthionine chloride U. S. P. (methylene blue), are capable, as Knusel and Vonwiller have shown, of staining the normal corneal epithelium. It is also important that any previous trauma to the cornea, such as taking the tension, shall be avoided, since changes in the epithelium visible with the slit-lamp may be seen in any cornea after use of the tonometer.

After examining a case of corneal dystrophy with the slit-lamp, it is of interest to record the tension, especial care being necessary to minimize trauma to the epithelium. As stated previously, my cases of typical epithelial dystrophy have all shown more or less hypotony. This is also true of the mild form. In one case the tension was 7 mm. Schiötz (old scale) in each eye, in others 9, 10 and 12 mm., while in no case was it above 17 mm. in either eye. It seems that this occurrence of hypotony may be considered characteristic of the mild form of dystrophy. That it may be of diagnostic importance was shown by a recent case in which its significance was neglected. This patient, a woman aged 72, complained of burning of the lids and slightly reduced vision. Slit-lamp examination showed an edematous corneal epithelium

with fine staining areas. Tension of the right eye was 28 mm. Schiötz (old scale) and of the left 22 mm., and the field showed a slight contraction. The nerve showed no cupping. It was noted that the corneal sensitivity was normal. In spite of this and the high normal tension, the condition was considered as probably one of mild epithelial dystrophy. On account of marked discomfort following the tonometry this was not repeated for some time. When the patient returned from a trip six months later, she was found to have definite signs of chronic glaucoma, with a tension of 31 mm. in the right eye and 33 mm. in the left. According to the observation of Fuchs and those who followed him, this might be considered a case of dystrophy with subsequent glaucoma. From observations in the mild form of dystrophy, however, I am more inclined to believe that the patient had had previous periods of increased tension, which had caused the epithelial changes, and that her case does not belong in the group of primary dystrophies.

A peculiar phenomenon observed in a number of these cases was an apparent marked sensitivity to the effects of epinephrine and cocaine on the pupil. A drop of either epinephrine 1:1,000 or 2 per cent cocaine instilled in the sac produced within a few minutes an almost maximal mydriasis. This may perhaps be explained by Fisher's observation that corneas showing any damage to the epithelium or swelling of the epithelial cells show also a marked increase in the speed with which drugs are absorbed by the cornea.

There can be no question that a number of observers have described the mild form of epithelial dystrophy and called it by other names, although only a few have sufficiently emphasized the frequency of the condition. Attention was called to some of these related conditions in previous reports.[2] A condition probably identical with that here discussed was described by Staehli as "minute defects of the corneal epithelium." He saw a number of such cases which showed nothing on ordinary examination, but, with the Nernst light and corneal microscope, showed numerous minute staining areas (often thousands). The corneal sensitivity was greatly diminished, and the condition was chronic and resistant to any treatment. Bartels[3] saw a number of cases in which the picture seems to have been very similar. Numerous epithelial defects were present which could be seen only with the slit-lamp. The condition had not cleared up in any case after six months' observation. Stoewer and Hessberg, in discussing his report, stated that they had seen a number of such cases. Bartels called the condition keratitis

2. Gifford, S. R.: Epithelial Dystrophy and Recurrent Erosion of Cornea as Seen with Slit-Lamp, Arch. Ophth. **54**:217 (May) 1925 (this article contains references not listed in the present paper); Am. J. Ophth. **9**:81, 1926.

3. Bartels: Ztschr. f. Augenh. **66**:480, 1928.

superficialis punctata. Vogt [4] described and illustrated a number of cases as keratitis epithelialis vesiculosa disseminata which he considered identical with keratitis superficialis punctata. He considered that this condition is of an inflammatory nature and has nothing to do with Fuchs' dystrophy. His cases differed from the cases here described in affecting principally children or growing adults who were subject to chronic conjunctivitis. He also described a keratitis epithelialis diffusa with gray dots in the cornea but no blebs. Pascheff,[5] after describing a typical case of superficial punctate keratitis, spoke of two other cases that resembled the mild form of dystrophy in the presence of numerous minute epithelial defects that continued to stain for long periods, larger defects occurring at intervals, however, with some pain. He considered this condition to be noninflammatory in nature and to have some relation to the corneal nerve endings. He called it the nervous form of superficial punctate keratitis.

Evidently the term superficial punctate keratitis has been used to describe several distinct conditions. What I have always understood by the term is the condition originally described by Fuchs and given by him this name. In this condition, as he describes it, a number of small gray infiltrates are present which elevate the epithelium and are just visible with oblique illumination. This, he stated, is usually associated with conjunctivitis, and clears up in from two to three weeks. The condition is undoubtedly familiar to most ophthalmologists. In my experience, the infiltrates are usually from four to ten in number and large enough to be visible with the naked eye in good focal illumination. They are accompanied by pain and congestion, and are obviously of an inflammatory nature. Such cases are like those described by Wright [6] in his study of an epidemic in Madras which he considered due to a virus like the herpes virus. This condition differs entirely from the mild form of dystrophy in the size and deeper location of the lesions, the pain and signs of inflammation, and the more acute course with healing in from two to three weeks.

Besides these cases I have seen a number of patients with a picture resembling the mild form of dystrophy but coming on acutely with some pain and congestion and running a relatively acute course, the staining areas clearing up within a month, without leaving a trace. The "striped dystrophy" described by A. von Szily and recently by Schulte [7] and the "flame-shaped epithelial keratitis" of Holmes Spicer may represent special forms of epithelial dystrophy, as in most cases the

4. Vogt: Atlas der Spaltcampenmikroskopie, ed. 2, Berlin, Julius Springer, 1930, p. 168.

5. Pascheff: Arch. d'opht. **43**:469, 1926.

6. Wright: Brit. J. Ophth. **14**:257, 1930.

7. Schulte: Klin. Monatsbl. f. Augenh. **82**:49, 1929.

course was extremely chronic. A case recently described by Bücklers [8] as "sickle-shaped changes in the epithelium" evidently represents another special form of dystrophy. Here the corneal sensitivity was normal. The patient was a woman of 51, and the condition remained much the same during observation. Lesions of the epithelium accompanying iridocyclitis which were described by Duverger and Lampert as superficial keratitis and by Vogt [9] as keratitis epithelialis are apparently similar to those in case 6 of my previous report. It is probable that such lesions occur in iridocyclitis more commonly than has been supposed, but they would seem to have nothing to do with true epithelial dystrophy. It would seem important to reserve the name keratitis for conditions of an inflammatory nature, while for the conditions here discussed the name "the mild form of epithelial dystrophy" seems proper, since the condition is in no sense a keratitis.

The relationship between epithelial dystrophy and recurrent erosion of the cornea has been considered by some observers, and was discussed in the previous report. While both are associated with reduced sensitivity of the cornea and may depend on some pathologic condition of the nerve endings, their clinical picture and course are entirely different. In recurrent erosion the onset is sudden, with very severe pain. A large bleb forms and ruptures, leaving the whole corneal epithelium loosened from its base, so that it may be peeled off in large pieces from Bowman's membrane. When it heals, the new epithelium may apparently be quite healthy until some slight injury or vasomotor disturbance causes a recurrence of the condition. In one patient, however, with recurrent erosion of the left cornea, the opposite cornea showed a typical picture of mild epithelial dystrophy, and during an observation period of over two years numerous staining areas were always to be seen, though vision remained 20/20. The left cornea, besides the scar of the erosion, showed a similar dystrophy over the rest of the cornea.

The treatment for the typical form of epithelial dystrophy is discouraging. Fuchs tried removing the corneal epithelium and applying iodine, as has been done with success in recurrent erosion, but in the dystrophy cases the results were only temporary and no other form of treatment seemed to have any effect on the condition. I tried the effect of phototherapy with the Birch-Hirschfeld arc-lamp, but saw no effect. Vogt performed corneoscleral trephining in two cases, one of which had showed no hypertension, and he reported a marked improvement in the condition of the cornea.

In the mild form, however, the use of ethylmorphine hydrochloride is apparently of great value. A 2.5 to 5 per cent solution of ethyl-

8. Bücklers: Klin. Monatsbl. f. Augenh. **86**:164, 1931.
9. Vogt: Ztschr. f. Augenh. **69**:262, 1929.

morphine hydrochloride in a 1 : 5,000 solution of mercuric cyanide was used in most cases, a drop being instilled three or four times a day. The effect on the symptoms was in most cases almost immediate. By beginning with the weaker solution the resulting chemosis did not continue long enough after instillation to be a serious inconvenience, and in a few cases in which this was more prolonged a 1 per cent solution was used. Not only was the burning, scratching sensation relieved, but in cases with reduction of vision this usually improved after a few days' use of ethylmorphine hydrochloride. The staining areas became fewer and less extensive, but never disappeared entirely in some cases, and in others did so only after weeks or months. Such cases showed punctate gray dots in the epithelium, and in all cases the epithelium continued to show a definite edema during the period of observation. The corneal sensitivity remained reduced in most cases, as well. A number of patients were seen in whom symptoms disappeared entirely while ethylmorphine hydrochloride was used, but recurred some time after it was stopped, to disappear again when it was resumed. It was continued for long periods in most cases, the number of instillations being cut down to one or two a day as symptoms subsided.

Another drug that seems of value is phenacaine. Besides its anesthetic effect, this drug is said to have a stimulating effect on the corneal epithelium, and in a number of cases a 0.5 per cent solution was used, either with the ethylmorphine hydrochloride or alone. A few cases that did not improve on ethylmorphine hydrochloride seemed to do better under phenacaine.

There is apparently no rational causative treatment for the condition. Imbalance of the glands of internal secretion has of course been invoked, and one observer advised the use of thyroid extract. There seems to be no definite basis for this opinion, but it may be said that one of my patients with other signs of hypothyroidism seemed to do better on small doses of thyroid. Aubineau [10] reported six cases, apparently of the typical form with hypercholesteremia, and believed that a low fat diet helped them considerably. The blood cholesterol was estimated on only one of my patients and was normal. Whitham believed that diabetes was a factor, as his three cases showed glycosuria. A number of my patients were examined with this in mind, but none showed glycosuria, and the blood sugar was not estimated. Blepharitis, when present, is treated by a 2 per cent ointment of yellow mercuric oxide, with some apparent benefit to the cornea, but the use of silver preparations or of any but the mildest astringents in the conjunctival sac seems to aggravate the condition.

10. Aubineau: Bull. et mém. Soc. franç. d'opht. **42**:283, 1929.

SUMMARY

1. The mild form of epithelial dystrophy is distinguished by the presence of edema of the epithelium, numerous minute staining areas, reduced corneal sensitivity and, usually, low intra-ocular tension.

2. It is not an uncommon condition, and would undoubtedly be recognized more commonly if every patient complaining of a burning and scratching sensation with slightly reduced vision were examined with the slit-lamp after staining with fluorescein.

3. The use of ethylmorphine hydrochloride or phenacaine, or both, seems to exert a definitely favorable effect on the condition.

METHODS OF FORMATION OF THE POSTERIOR ABSCESS IN ULCUS SERPENS*

BERNARD SAMUELS, M.D.
NEW YORK

Following the description of Saemisch (1870), authors of textbooks define ulcus serpens as a disk-shaped loss of substance in the superficial layers of the cornea, near the center, having a tendency to spread over the surface in one direction rather than to extend into the deeper layers, the process being associated with an exudate in the anterior chamber (hypopyon). To Axenfeld and Uhthoff (1896) belongs the credit of the discovery that the pneumococcus is the cause of the typical ulcus serpens.

Many cases of ulcus serpens are complicated by the presence of an infiltration of leukocytes separated from the ulcer by a less infiltrated tissue, the so-called posterior abscess, in the proximity of Descemet's membrane, while other cases show no infiltration whatever in this region. The manner of the formation of the posterior abscess is still a matter of dispute. One school, headed by Elschnig, holds to the view that the leukocytes composing the abscess represent a migration from the deep ciliary vessels at the periphery of the cornea. The other school, of which Wintersteiner was an exponent, believes that the cells come originally from the iris, finding their way forward through the aqueous and Descemet's membrane.

The purpose of this paper is to throw light, if possible, on:

1. The factors that produce the abscess.
2. The factors that prevent its formation.
3. The methods of its formation.

The material on which this study is based consisted of microscopic preparations from fifty eyes, in none of which the ulcer as a whole had ruptured. The eyes were those of adults, mostly in middle life or old age. The onset of the ulcer was recorded as spontaneous or due to slight injury. Forty-two eyes showed evidence of glaucoma, chiefly absolute glaucoma, and eight eyes were set down as previously normal. The glaucomatous eyes coincided almost exactly with those said to have been spontaneously affected and the rest to those that were injured. That there were so many glaucomatous eyes available is probably explained by the fact that not only are these eyes prone to ulcus serpens, but being already blind they are more likely to come to excision, and at an earlier

* Submitted for publication, July 3, 1931.
* Read before the Oxford Ophthalmological Congress, England, July 11, 1931.

date, than eyes previously normal. So far as glaucomatous and non-glaucomatous eyes are concerned there appears to be no essential difference in the progress of the ulcer. In examining the specimens the following points were noted in each ulcer:

1. Extension Along the Surface: In most cases the loss of substance ranged from one third to three fourths of the surface, indicating well advanced stages.

2. Depth: There was no instance in which the ulcer penetrated deeper than the middle layers of the cornea. In several cases, in which

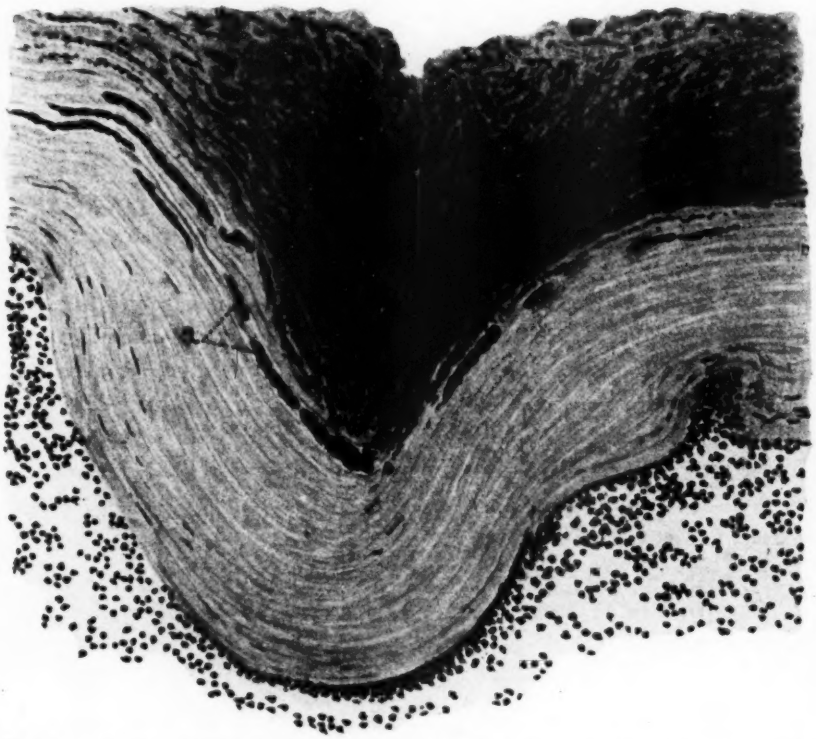

Fig. 1.—Toxins from colonies of bacteria (*a*) have diffused directly through the underlying layers of the cornea, causing death of the fixed corpuscles.

the surface extension was very great, only the superficial layers were involved, so that ulcers covering the greatest area are not always the deepest.

3. Extent of Necrosis in the Cornea: This is inferred from the condition of the fixed corneal corpuscles, judging by their disappearance or poor staining reaction (necrosis). Thus, in the area adjacent to the progressive border of an ulcer, the cells in the stroma may have entirely disappeared, while farther away the cells that are present may take the stain poorly, indicating that they are greatly affected. There is no way

of telling accurately the condition of the lamellae, because they stain lightly or not at all under all circumstances, whether normal or pathologic. Therefore the lamellae forming the floor of a recently cleansed ulcer may look clinically about as transparent as the adjacent normal stroma. It is the cellular infiltration that causes the opaqueness. The lamellae may survive when all the corpuscles are dead. In the course of repair new cells proliferate from the periphery into the area devoid of corpuscles and resuscitate the lamellae. When the lamellae are also necrotic this part breaks down and is cast off, resulting in a defect—the ulcer.

4. Anterior Infiltration of the Cornea (Progressive Border): In respect to the progressive border and its connection with necrosis of the fixed corneal corpuscles, the specimens showed variations: (*a*) a border greatly infiltrated (in the initial stage), with necrosis of the fixed cor-

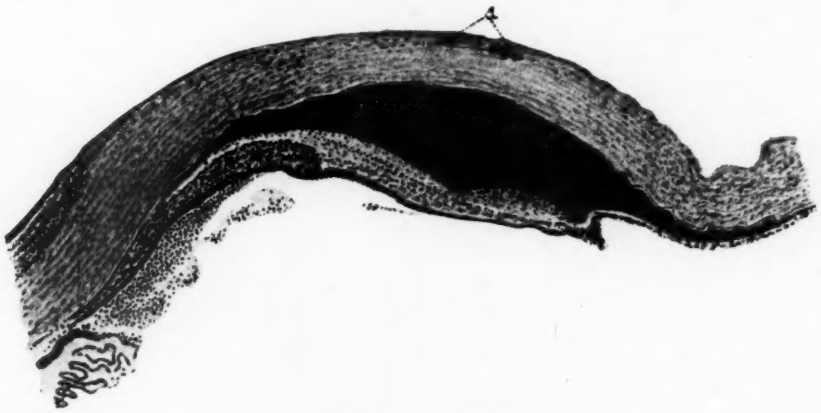

Fig. 2.—Toxins from colonies of bacteria (*a*), having reached the anterior chamber, have produced an enormous hypopyon by irritating the iris. Later the lamellae would have been infiltrated by leukocytes from the blood vessels at the limbus.

puscles confined to the immediate neighborhood; (*b*) a border slightly infiltrated (in the initial stage) with widespread necrosis of the fixed corpuscles; (*c*) a border moderately infiltrated (in the initial stage), with moderate necrosis of the fixed corpuscles; (*d*) a border without infiltration (in the terminal stage) in which the leukocytes have disappeared in the cleansing of the ulcer, and in which there has not been time for the fixed corpuscles in the periphery to proliferate and send in new nuclei.

5. Posterior Infiltration (Posterior Abscess): There is considerable diversity in size and shape. There are (*a*) small flat abscesses, composed of one or more rows of cells, and (*b*) large oval or spherical abscesses protruding into the anterior chamber. A few of the abscesses noted were so large as to occupy about one half of the posterior surface

of the cornea. The abscesses may be located in different tissues: (*a*) in the most posterior layers of the cornea, (*b*) between these and Descemet's membrane or (*c*) within the split layers of Descemet's membrane. Small abscesses are usually in the stroma or between it and Descemet's membrane, while large abscesses are often within the layers of Descemet's membrane.

6. Relationship of the Site of the Posterior Abscess to the Floor of the Ulcer and to Its Progressive Border: In eight examples the abscess was located almost exactly opposite the middle of the floor of the ulcer.

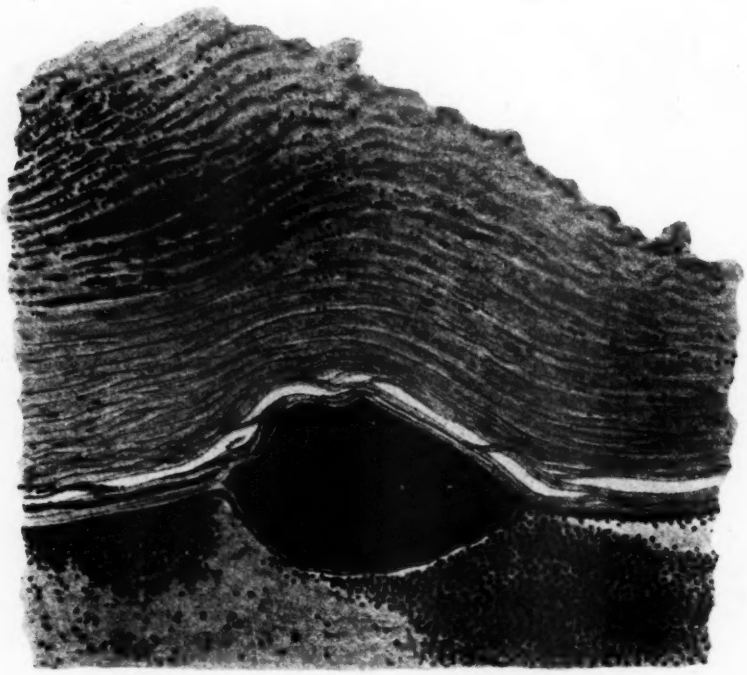

Fig. 3.—Posterior abscess, produced by the action of leukocytes that have migrated along the anterior surface of Descemet's membrane, from the deep blood vessels at the limbus. Note the splitting of the membrane.

The majority were on the side of the progressive border, but always a little removed toward the center of the floor, as if the infiltrating wedge anteriorly progressed too rapidly for the abscess to follow. This was especially true when the abscess was confined between the split layers of Descemet's membrane, in which the cells would meet with great resistance in trying to keep pace with the progressive border. Therefore the site of an abscess may indicate its age. An abscess left behind, opposite the middle of the floor of an ulcer, must have been formed

early, while one at the periphery of a large disk opposite the progressive border is evidently of more recent origin.

7. Exudation in the Anterior Chamber (Hypopyon): The amount varies from a few scattered leukocytes to a quantity that almost blocks the chamber. The disposition of the cells depends on the amount of fibrin in the aqueous. When there is very little fibrin the cells are movable, sinking to the bottom of the chamber. Where there is much fibrin the cells are no longer movable. Two cases showed the exudate partly free and partly caught in fibrin. The free cells were at the bottom of the chamber (hypopyon) while those in the fibrin formed a saclike mass agglutinated to the surface of a large projecting abscess.

8. Behavior of the Three Foci of Leukocytes (Progressive Border, Posterior Abscess and Hypopyon) to One Another: There were: (*a*)

Fig. 4.—A dense collection of leukocytes on the posterior surface of Descemet's membrane, opposite the progressive border of a serpiginous ulcer. Note the disappearance of the corneal corpuscles and the absence of any infiltration in the stroma.

cases of posterior abscess without exudation in the aqueous chamber (a few cells were always present); (*b*) cases of exudation in the aqueous chamber without posterior abscess, and (*c*) cases of both posterior abscess and exudation in the anterior chamber.

9. Condition of Descemet's Membrane: When there is an exudate on the anterior or posterior surface, or on both surfaces, the membrane may show local swelling, thinning or disappearance, but more often it is split into layers enclosing a large abscess.

THE THEORY OF LEBER

An explanation of the presence of the aforementioned three distinct foci of leukocytes—progressive border, posterior abscess and hypopyon

—follows. According to the theory of Leber, toxic substances produced by the pneumococci diffuse:

(*a*) Within the corneal tissue toward the periphery, causing dilatation of the marginal blood vessels with emigration of leukocytes from the superficial network of vessels, forming the progressive border, and from the deep marginal vessels, forming the posterior abscesss; (*b*) through the cornea, into the aqueous chamber, irritating the blood vessels of the iris and producing exudation into the aqueous. This is the shorter route, although probably the more difficult one, through which the toxins may diffuse, being across instead of parallel with the lamellae.

The application of Leber's theory is as follows:

1. *Factors that Produce the Abscess.*—(*a*) Posterior Abscess without Hypopyon: The possible cause is a moderate degree of toxicity, so that

Fig. 5.—Descemet's membrane undergoing invasion and destruction by leukocytes along its posterior surface. There is an absence of leukocytes anteriorly.

the action of the toxins is sufficiently strong within the cornea to excite emigration from the marginal vessels, both superficial and deep, but after passing into the aqueous the toxins are so diluted that they produce an insignificant exudation from the iris. A moderate degree of toxicity here is indicated by a zone of necrosis in the stroma of moderate extent accompanying the ulcer. There are cases, however, in which the hypopyon may be reduced on account of extensive anterior peripheral synechiae, with atrophy of the iris and obliteration of its blood vessels.

(*b*) Exudation in the Anterior Chamber Without Posterior Abscess: The possible cause is high toxicity so that the leukocytes coming from the marginal vessels are paralyzed or killed (negative chemotaxis) before they can migrate far into the cornea, while in the aqueous chamber the toxins being diluted cause the hypopyon (posterior chemotaxis). A high degree of toxicity here is indicated by the enormous necrosis of the corneal corpuscles in all of the layers.

(*c*) Posterior Abscess and Hypopyon (the Most Frequent Picture): The possible cause is the presence of toxins of sufficient strength to excite emigration from the marginal vessels, both superficial and deep, as well as from the vessels of the iris. Under these conditions there is considerable necrosis of the cells in the stroma surrounding the ulcer.

2. *Factors that Prevent the Formation of the Posterior Abscess.*—The possible cause is high toxicity, as a result of which leukocytes from the deep ciliary vessels are checked in their advance (negative chemotaxis). A high degree of toxicity is indicated by a far-flung absence of any cells, the fixed corpuscles being killed and the leukocytes repelled (negative chemotaxis).

3. *Methods of Formation of the Posterior Abscess.*—In studying the origin of an abscess the state of Descemet's membrane and of the endothelium is of prime importance. It has already been noted that the

Fig. 6.—Posterior abscess that was produced by an accumulation of leukocytes in front of Descemet's membrane which has ruptured. The ulcer is clearing.

membrane may be damaged or destroyed. It is often said that Descemet's membrane is impervious to leukocytes, but there is no doubt that leukocytes can penetrate through the membrane after the endothelium is destroyed, either by way of invisible pores or by forcing themselves through the solid structure. The detachment or destruction of the endothelium is the first stage in the attack on Descemet's membrane. Before the membrane has been split or dissolved, leukocytes may penetrate through it and invade the posterior lamellae of the cornea. A number of the specimens examined showed leukocytes actually in the membrane. It is therefore possible for leukocytes in the aqueous chamber to form a posterior abscess, by being attracted anteriorly (positive chemotaxis) through an intact Descemet's membrane or through one that has been damaged or destroyed locally.

(*a*) Abscess without Exudation in Aqueous Chamber: There were six specimens in which the peripheral origin was established by the fact that there was a direct connection of leukocytes along the anterior sur-

face of Descemet's membrane between the abscess and the ciliary vessels, while but a few scattered cells were seen along the posterior surface.

(*b*) Abscess with Exudation in Aqueous Chamber: Of these there were thirty-two examples, divided into two groups:

(1) Twenty-two in which the abscess was considered to be of peripheral origin because the actual connection of the cells with the deep ciliary vessels was seen, anterior to Descemet's membrane, while there was no evidence of invasion from the posterior surface.

(2) Ten cases in which the abscess could be accounted for in no other way than by an invasion from the aqueous, there being no connection between the abscess and the deep peripheral vessels. However, the absence of cells on the anterior surface of Descemet's membrane is not a positive proof that they may not have been present and have disappeared in the healing process.

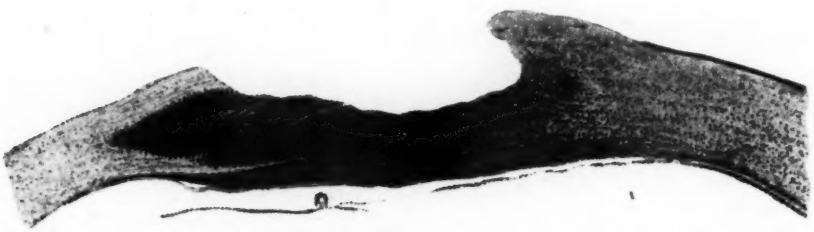

Fig. 7.—The floor of the ulcer is clean, but the abscess is still present. Descemet's membrane is invisible at several points, as if the abscess is about to open into the anterior chamber.

ABSCESSES OF UNCERTAIN ORIGIN

There were twelve preparations in which it was not possible to decide the derivation of the cells of the abscess. In one case a globular abscess was located between the split layers of Descemet's membrane, and as there were no cells on the anterior surface, between the abscess and the periphery, and no cells in the anterior chamber, all having disappeared in the cleansing process, the origin was obscure. A number of slides showed an equal amount of cells anterior and posterior to fragmentary membranes so that it is difficult to decide which aggregation preceded the other.

OUTCOME OF A POSTERIOR ABSCESS

The size of an abscess and the particular tissue in which it is located play a rôle in its ultimate fate. Small flat abscesses in the stroma or between it and Descemet's membrane are more rapidly absorbed than those larger ones isolated between the layers of Descemet's membrane, according to the preparation. In most instances, in the process of heal-

ing, the posterior abscess is the last one of the three foci of infiltrations to leave. A posterior abscess may disappear in two ways, either by absorption of the cells within the tissue of the cornea or by their absorption in the aqueous after the abscess has ruptured.

CONCLUSION

The majority of posterior abscesses are brought about by an aggregation of leukocytes derived from the deep ciliary vessels, traveling anterior to Descemet's membrane. Many, however, are formed by cells that have found their way forward into the cornea from the iris, through Descemet's membrane. It is probable that a considerable number of abscesses are derived from both sources.

THE MECHANISM OF ACCOMMODATION

FACTS AND FANCIES *

W. H. LUEDDE, M.D.
ST. LOUIS

At the celebration for medical progress arranged by the University of Pennsylvania last October, Prof. A. V. Hill [1] of the Royal Society, London, England, in an eloquent address, suggested a creed for the Johnson Foundation including the following tenets: "I believe in the utility of theories, provided they are not regarded as facts. I admit the necessity of criticism and disbelief; I hope and pray the damnation of those who are not strictly honest; and I am convinced of the complete reasonableness of natural phenomena."

More recently Dr. Robert A. Millikan,[2] acting as toastmaster at a dinner of the California Institute of Technology in honor of Professor Einstein, stated that "the distinguishing feature of modern scientific thought lies in the fact that it begins by discarding all *a priori* conceptions . . . and takes instead as its starting point well authenticated, carefully tested experimental facts no matter whether these facts seem at the moment to fit into any general philosophical scheme or not."

When distinguished scientists seriously question well established and time honored theoretical solutions of the fundamental problems of the universe, it may not be out of order to consider, in a critical manner, the generally accepted theory about the mechanism of accommodation. It is a theory that through its age and honorable heritage has almost achieved the authority of fact, yet it lacks "the complete reasonableness of natural phenomena." Or, as Ovio [3] put it, "This state of elasticity of the crystalline lens in repose has at first approach several things that seem paradoxical in spite of the great authority of Helmholtz,[4] who made it the foundation for his theory of accommo-

* Submitted for publication, March 29, 1930.

* From the Department of Ophthalmology, St. Louis University School of Medicine.

* Read before the Section on Ophthalmology at the Eighty-Second Annual Session of the American Medical Association, Philadelphia, June 10, 1931.

1. Hill, A. V.: The Physical Reasonableness of Life, J. A. M. A. **95**:1393 (Nov. 8) 1930.

2. Millikan, R. A.: Address, Jan. 15, 1931, California Institute of Technology, broadcast by radio, confirmed by personal communication to the author.

3. Ovio: Anatomie et physiologie de l'oeil dans la serie animale, translated by Dejean, 1927.

4. von Helmholtz, H. L. F.: Handbuch der physiologischen Optik, Leipzig, L. Voss, 1867, p. 110.

dation. Numerous tests have been made to see if this could be confirmed as a fact, or if one could rather unite the various factors into a different mechanism."

So many volumes have been filled with experimental and clinical observations and mathematical calculations pertaining to this mechanism, all more or less interspersed with fanciful conceptions, that one may easily "fail to see the forest on account of the trees." In attempting to outline a path through this maze of fact and fancy one is reminded of Tscherning's [5] quotation, from Guy de Chauliac, in humble apology for presenting observations in contradiction to opinions expressed by the great scientist von Helmholtz: "A child may see farther than a giant if he is seated on his shoulders." Only, in this instance, the child is seated on the shoulders of two giants and they seem to want to walk in opposite directions.

A satisfactory summary of recorded facts may seem hopeless of attainment on account of contradictions. There is, however, consolation in knowing that actual facts never contradict and that they can be coordinated by the elimination of error.

Langenbeck [6] (1849), Cramer [7] (1853) and Helmholtz [8] (1853) are credited with priority in furnishing objective proof that the changes within the human eye incident to accommodation for near vision are essentially and exclusively alterations in the form of the crystalline lens.

Half a century earlier, Thomas Young [9] (1801) by two original and well known experiments had eliminated alterations in the convexity of the cornea or increase in the length of the eyeball as possible factors in the mechanism of accommodation in his own eye.

In the following seven paragraphs, embracing six objective observations and one subjective observation, Prof. Carl von Hess,[10] in an authoritative posthumous publication, classifies what takes place within a normal youthful eye in changing from the position of rest to near vision. The first four paragraphs pertain to a moderate effort of

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5. Tscherning: Hermann von Helmholtz et le théorie de l'accommodation, 1909.

6. Langenbeck: Klinische Beiträge aus dem Gebiete der Chirurgie und Ophthalmologie. Göttingen, 1849; quoted by von Hess.

7. Cramer, A.: Het accommodatievermogen der oogen, physiologisch toegelicht, Haarlem, de erven Loosjes, 1853; quoted by von Hess.

8. von Helmholtz, H. L. F.: Ueber eine bisher unbekannte Veränderung am menschlichen Auge bei veränderter Accommodation, Monatsb. d. Akad. zu Berlin, Feb. 3, 1853; quoted by von Hess.

9. Young, Thomas: On the Mechanism of the Eye, Phil. Tr., London **1**:23, 1801.

10. von Hess, Carl: Die Akkommodation beim Menschen: Vergleichende Akkommodationslehre, p. 145; Photoreceptoren, in Handbuch der normalen und pathologischen Physiologie, XII, I, II.

accommodation, while the changes noted in paragraphs 5, 6 and 7 can be seen only when the strongest possible effort is made, which in some instances can be attained only by the aid of myotics:

1. The pupil becomes smaller.

2. The anterior vertex of the lens moves forward so that the anterior chamber becomes more shallow in its central zone.

3. The peripheral segment of the anterior chamber does not become noticeably shallow and in many eyes an actual increase in its depth through retraction of the peripheral zone of the iris may be noted.

4. The convexity of the visible anterior pupilary segment of the lens is considerably increased. Whether the convexity of the posterior surface of the lens is increased is not entirely certain.

5. When the strongest possible effort of accommodation is made, the crystalline lens will sink approximately 0.25-0.3 mm. in response to gravity according to the position of the head, temporally, nasally, frontally or infra-orbitally toward the ciliary body.

6. By short jerking movements of the eye the lens may be seen to tremble. If the eye is not moved, even a maximal accommodative effort fails to produce any trembling of the lens. The distinctness and degree of the trembling of the lens varies greatly in different individuals. In many cases the trembling is so marked that the sector of the overlying iris also trembles.

7. Observation of the lens spectrum of the observer's own eye will show that when an accommodative effort has reached a certain degree there is a sudden transposition upward of the entoptic lens figure (particularly noticeable in single outstanding points of the image corresponding to tiny lenticular opacities). When the accommodation is then suddenly relaxed, a similar movement downward is to be noted. During and immediately after short jerking movements of the eyeball, while the accommodative effort is at its height, the trembling of the entoptic image of the lens may be noted.

From this recital of scientifically demonstrable changes in the human eye during accommodation, it is easy to follow von Hess in his reference to the experimental studies of Hensen and Voelckers.[11] The latter demonstrated beyond question that the point of fixation of the ciliary muscle is at its anterior extremity and that its contraction produces immediate traction on, and forward movement of, the choroid throughout the circumference of the eyeball with gradually lessened effect farther back until it ceases at the posterior pole. Tips of needles inserted through the sclera into the ciliary body manifested no forward or backward movement, when electrical excitation was applied, thus proving that the ciliary body does not change its position with reference to the scleral wall. Similarly, needles in the macular region at the posterior pole remained unmoved. The earlier experiments made on

11. Hensen and Voelckers: Experimentaluntersuchung ueber den Mechanismus der Accommodation, 1868.

living animals' eyes were repeated by Hensen and Voelckers [12] on a human eye immediately after enucleation with the same results.

Von Hess and all who seek to uphold von Helmholtz' suggestion of a mechanism of relaxation to account for the changes in the form of the lens during accommodation have endeavored in theory to connect the forward movement of the choroid seen at the very beginning of contraction of ciliary muscle with the evident relaxation that can be demonstrated only at the highest stage of this action. It must be remembered that the ordinary range of accommodation fails to disclose relaxation. Gullstrand [13] points out that, "Since the relaxation of the zonule does not begin until the contraction is greatest, it must be kept under tension during normal contraction by an axipetal movement of the points of insertion on the lens, especially of those on the anterior surface."

If the ciliary muscle were placed anterior to the lens it would be relatively easy to understand how continued contraction might produce a gradual release of zonular tension, eventually culminating in a final complete relaxation. But the ciliary muscle lies behind the plane of the equator of the lens. According to Salzmann,[14] the anterior end of the ciliary muscle begins "some 3 mm. behind the anterior border of the ciliary body." As has just been noted by the undisputed evidence of Hensen and Voelckers' experiments, the ciliary body does not move forward during accommodation. It thus constitutes a positive check in the forward movement between the anterior end of the choroid and the anterior end of the ciliary muscle, which is fixed. Only a vivid fancy that disregards definite anatomic facts and relations can push the meridional fibers of the zonule forward past a ciliary body that does not move forward and thus produce the postulated relaxation of the anterior capsule of the lens at the beginning of accommodation.

Other direct checks to the forward movement of the zonule are found in the manner of its attachment to the surface of the ciliary body. For demonstration of these facts a reference to the anatomy and histology of these structures becomes necessary. Salzmann points out that the ciliary body forms a girdle about 5 to 6 mm. in breadth. It is divided into an anterior zone 2 mm. wide, called the corona ciliaris, from which spring the ciliary processes, and a posterior zone, the

12. Hensen and Voelckers: Ueber die Accommodationsbewegung der Chorioidea im Auge des Menschen, des Affen und der Katze, Arch. f. Ophth., vol. 19, no. 1, p. 156.

13. Gullstrand, Allvar: Zusaetze, in von Helmholtz, H. L. F.: Handbuch der physiologische Optik, ed. 3, Leipzig, 1909, vol. 1; translated by James P. C. Southall, 1924.

14. Salzmann, M.: Anatomie und Histologie des menschlichen Augapfels im Normalzustande, Leipzig, Franz Deuticke, 1912; translated by Dr. E. V. L. Brown.

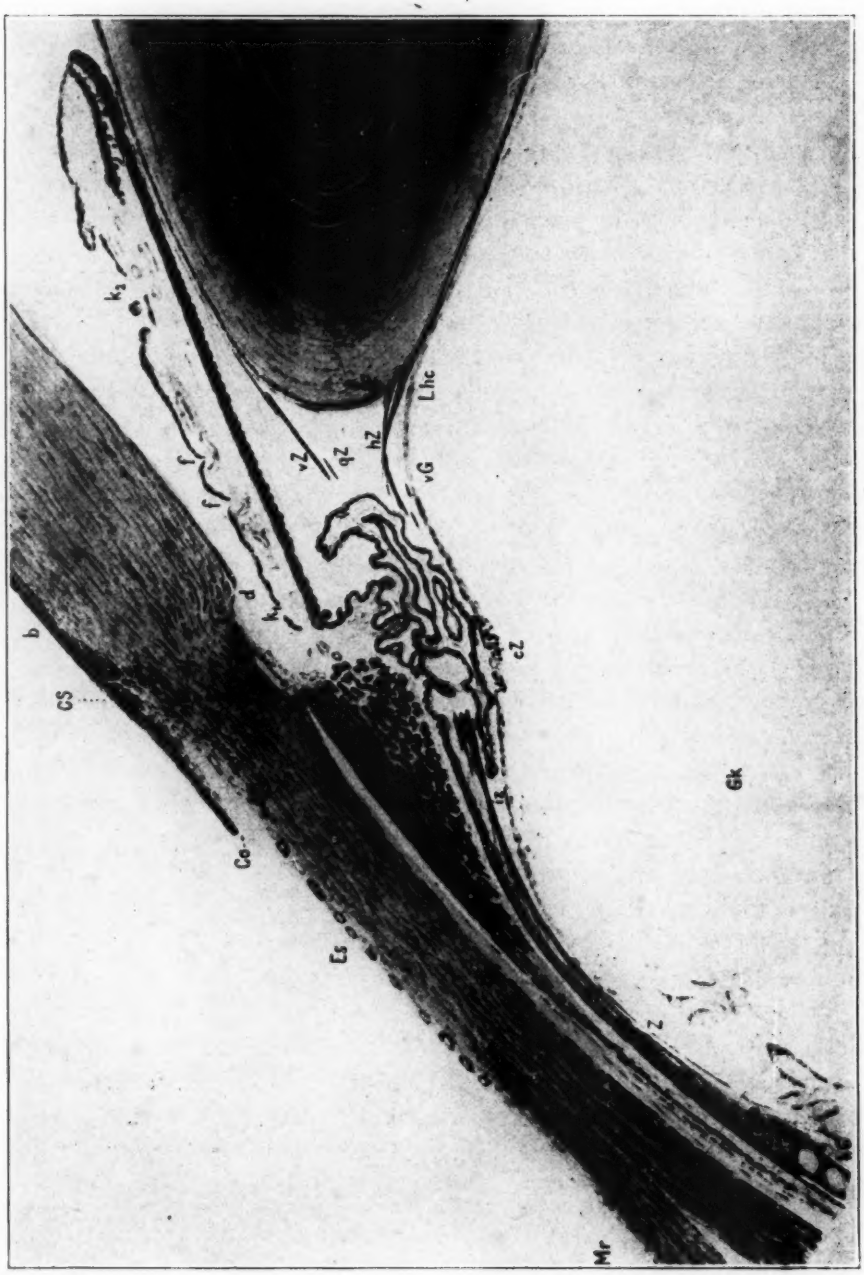

Fig. 1.—Meridional section through iris and ciliary body, and environment. Reduced from a magnification of 30 diameters. Reproduced, by permission, from Salzmann's Anatomy and Histology of the Human Eyeball.

orbiculus ciliaris, in which lies the mass of ciliary muscle fibers, both meridional and circular.

The meridional, or larger, fibers of the zonule lie between the inner surface of the orbiculus, or posterior zone of the ciliary body, and the vitreous. All over the inner surface of this zone, the meridional fibers of the zonule are joined by finer fibers attached to the ciliary epithelium and coursing "from behind and without, forward and inward" (Salzmann). Thus the bulk of the meridional fibers is attached to the ciliary body in a way that the posterior end of the ciliary muscle might move forward without pulling on them; but the meridional (or accommodative) fibers could not move forward unless the ciliary body itself was advanced. These fine auxiliary fibers, with other straight fibers, are caught in a narrow-angled crossing "just behind the corona ciliaris," which, as Salzmann states, by "double anchorage brings about a stronger fixation of the entire zonular fiber mass at the posterior border of the corona ciliaris."

Since all these attachments lie behind the equator of the lens and since Hensen and Voelckers' experiments demonstrated by the insertion of needles that forward movement ceased in the ciliary body itself, it is obvious that there is little likelihood of relaxation of the anterior attachment of the zonule during the ordinary range of the accommodative mechanism.

Furthermore, it is obvious that the natural inward, or axipetal, bulge of the ciliary body under muscular contraction must modify the course and may thus, in effect, shorten the meridional (or accommodative) fibers of the zonule. This thickening of the ciliary body is greatly accentuated by the circular portion of the ciliary muscle, the so-called Mueller's [15] muscle, which is placed as the innermost portion of the ciliary musculature.

Mueller's muscle is especially well developed in persons with hyperopia. In the myopic type, the circular portion is very weakly developed or fails entirely. To the circular muscle is given the required auxiliary action demanded for clear vision by an eyeball that is relatively short. This increased inward projection, if it occurred anterior to the plane of the equator of the lens, might be interpreted as an aid to relaxation. But as the entire muscular mass is behind that plane, the effect of any inward bulge will be to indent or bend the fibers that pass forward next to the vitreous. By bending inward, they are really shortened, and rearward traction at their insertion on the anterior capsule will result. Such direct rearward traction on an

15. Mueller, Heinrich: Anatomische Beitraege zur Ophthalmologie, Arch. f. Ophth. **3**:1, 1857; quoted by Salzmann.

empty lens capsule seems to explain the "moderate waviness" noted by Basil Graves [16] with the aid of the slit lamp after instillation of physostigmine (eserine), the suspensory fibers being relaxed.

Salzmann warns against the idea "that the ciliary muscle of the hyperope is thought of as hypertrophic and that of the myope as atrophic because the whole mass of muscle in the myopic type may be even greater than in the hyperope." He adds, "all things considered, one must conclude that the form of the ciliary muscle depends upon its length, i. e., the longer the muscle from whatever cause, the more the myopic type comes to expression, the shorter it is, the more the hypermetropic type comes out."

One is tempted to speculate on the likelihood that the long slender muscle of the myopic type may be an important factor in the production of pathologic changes in the retina and choroid at the posterior pole of the eye, and in the greater liability to detachment of the retina found in high myopia. Even though the myopic person makes less demand on his accommodation, its exercise is attended by relatively greater forward traction on the choroid, retina and vitreous with less backward restraint from Mueller's muscle as indicated by consideration of these anatomic fundamentals. Clinical experience has confirmed the beneficial effect of prolonged cycloplegia in pathologic myopia.

The posterior zonular border "lies some 1.5 mm. in front of the ora serrata" and therefore at the anterior border of the base of the vitreous. While the bases of the vitreous, ora serrata and choroid are in close union, Salzmann states: "I have not been able to convince myself of a direct connection between the zonular fibers and the border of the retina or the supporting tissue of the retina." Thus, it appears that while the zonule has diffuse attachment to the inner surface of the rather immobile ciliary body, it cannot be relaxed by advancement of the choroid.

The inverted "Λ" made by the fibers of the zonule as they are attached to the anterior and posterior capsules on either side of the equator is described by Salzmann as follows: "The anterior surface of the triangle is straight; the posterior describes a bow apposed to the wall" of the vitreous surrounding the fossa patellaris. In this anatomic detail more mute evidence is found of probable traction on the anterior fibers and direct indentation by the vitreous on the posterior fibers.

The final relaxation with the greatest effort of accommodation is easily explained. It is not due to the advance of the choroid, but is the result of the narrowing of the inner ring of ciliary body incident

16. Graves, Basil: Tr. Am. Ophth. Soc., 1925, p. 184.

to the regular thickening of muscular contraction which must release the suspensory fibers of the zonule that are attached just behind the corona ciliaris. This narrowing of the inner ring of the ciliary body is well depicted by Hess [10] in sketches of human eyes treated with atropine and with physostigmine. It appears to be entirely independent of the mechanical activity during the ordinary range of accommodation. Probably the only helpful effect which this final relaxation provides for the function of accommodation is the forward movement of the lens when looking downward which Hess [17] described.

The most popular fallacy regarding the mechanism of accommodation was von Helmholtz' [4] assumption that the lens was made up of an elastic substance. The crystalline lens consists of a firm nucleus surrounded by a soft slimy ("schleimige," Hess [17]) or mucilaginous (Tscherning [5]) substance. The nucleus is small, and the soft cortex predominates in youthful lenses that are most capable of accommodative change of form. As the firm nucleus grows larger with increasing age, the capacity to accommodate the eye for near vision becomes progressively less and is finally entirely lost. Therefore, it is manifest that the ability to accommodate somehow requires the viscous soft plastic material which is actually found to be the character of the cortex of the lens and not the imagined elastic tissue first postulated by von Helmholtz.[4]

Nature's selection for man and higher mammalia, of this most impressionable material, softer than any to be found in the crystalline lenses of other animals of the vertebrate order, should have supplied the hint to theorists that these lenses would respond to external influences instead of intrinsic elasticity. Schweigger [18] pointed out that even liquefied lenses, within their capsules, tend to take a spherical form when free from external influences. There can be, in such instances, as Hess [17] asserts, no thought of elasticity of the lens substance.

The spherical form in such cases must be taken in response to the well known physical laws of surface tension according to which a liquid always assumes the form having the smallest surface area compatible with existing conditions. Such a spherical form, however, is modified by the smallest imaginable external contact.

Having been obliged to dismiss the theory of change of form due to elastic substance within the lens capsule when it was found not to be there, the rôle was transferred to the few elastic fibers found scattered throughout the lens capsule. Nevertheless, it is interesting

17. von Hess, Carl, in Graefe-Saemisch: Handbuch der gesamten Augenheilkunde, ed. 3, Leipzig, Wilhelm Engelmann, 1900, chap. 12.

18. Schweigger, quoted by von Hess: Vergleichende Akkommodationslehre, p. 154.

to recall how imaginations were exercised to support the original belief of von Helmholtz [4] that the lens substance did possess this quality.

Among the earliest of these was the proposal of Hensen and Voelckers,[11] who suggested that the substance of the lens might be made up of tiny bent tubules that tended to become straightened when their fluid content increased, thus increasing the lenticular convexity. With the conscientiousness of true scientists, they added, "We are obliged to confess that this assumption of increased filling of the lenticular tubules remains purely hypothetical, but as this question lies at the very heart of the accommodative action, hence we permitted ourselves to hazard an explanation."

E. Treacher Collins [19] presented a detailed and strictly scientific investigation of the embryonic development of the crystalline lens, its capsule and zonule, including some interesting notes on comparative anatomy, to the tenth Congress of Ophthalmology, at Lucerne, in 1904. He points out that "There are thus developed in the growth and expansion of the eye forces dragging on the posterior part of the lens capsule forwards and outwards, and on the anterior part of the lens capsule backwards and outwards. The effect of this on the elastic curved lens fibers is to cause them to become more bent and kept in a state of tension. A state of tension which is only relaxed when by the contraction of the ciliary muscle the suspensory ligament is slackened and the pull on the capsule relieved."

Elasticity is that property of a body which causes it to resist deformation and afterward to recover its original shape and size. Since the subcapsular layers of the lens which surround its nucleus when released show no tendency to have any form of their own, it is hopeless to postulate true elasticity for them.

The presence of elastic fibers in the lens capsule raises the question whether these elastic fibers are there to cause increased convexity of the lens or to flatten its surfaces in a state of rest. The latter would be the more natural physiologic function. For instance, Hensen and Voelckers [11] observed that the choroid was pulled forward somewhat slowly by contraction of the ciliary muscle but returns more snappily because of the elastic tissue in the choroid when the electrical stimulation of the muscle ceases.

Similarly, the elastic fibers scattered about in the connective tissue of the capsule of the lens may have as their function the maintenance of the relatively flattened surface of the lens for distant vision when the ciliary muscle is at rest. There is no doubt that radiating traction

19. Collins, E. T.: On the Development of the Accommodative Power of the Human Lens, X Cong. Ophth., Lucerne, 1904, pp. 244-251.

by the suspensory fibers, while accommodation is at rest, also tends to flatten the anterior and posterior surfaces of the lens, as pointed out by Treacher Collins and as observed by von Hess [10] and others who noted tiny elevations at the equator of the lens corresponding to these attachments in atropinized eyes.

Fincham,[20] finding more elastic fibers peripherally than at the center of the anterior capsule, thought that this distribution might aid in flattening the periphery and permit relatively greater bulging of the capsule at the center during accommodation. Further study of the lens capsule with special reference to the greater thickness in certain zones, the occurrence of zonular lamellae and variability in the distribution of elastic fibers, may shed further light on their rôle in accommodation. Holloway and Cowan [21] state that "sufficient evidence has not been brought forward to establish a uniformity of opinion concerning the extent of the zonular lamella."

If the elasticity in the lens capsule were intended to increase the convexity of the lens, one might expect that, when cut, its edges would show a tendency to roll inward. Salzmann [14] states that its cut edges tend to roll outward, which suggests a predominant tendency to reduce or flatten the lens surface. In any event, it is apparent from its construction that the lens is intended to respond more readily to impressions from without than to create them from within.

Von Hess,[17] emphasizing how slight an external influence might alter the form of the youthful crystalline lens, demonstrated that when such a lens free of attachments and surrounded by air "lies on a level surface it is noticeably flattened by its own weight." This refers to the youthful lens within its capsule. It is an experiment that can be repeated easily. It shows that the capsule of a young lens, i. e., at its best so far as the range of accommodation is concerned, does not have enough power to produce a convexity of the surface of that lens sufficient to resist its own weight when placed on a flat surface. It seems quite out of order, therefore, to assign to the relatively feeble elasticity of the lens capsule the major rôle in producing the convexity of the crystalline lens in accommodation.

Another misunderstanding that needs to be cleared up is the misapprehension that the vitreous acts on the posterior surface of the crystalline lens solely by hydrostatic pressure. If von Helmholtz could have known what histologic research has since revealed concerning the structure of the vitreous humor, it might have averted three quarters

20. Fincham: Changes in the Form of the Crystalline Lens in Accommodation, Tr. Ophth. Soc. **26**:5, 1924.

21. Holloway and Cowan: Concerning Lamellar Membranes of the Anterior Surface of the Lens, Am. J. Ophth. **14**:181 (March) 1931.

of a century of controversy. Unfortunately, like other controversies, this one has not been conducted always without rancor and personal affront for which, however, von Helmholtz was not in the least to blame.

In rejecting the proposal of Cramer and Donders [22] for a mechanism of accommodation in which the vitreous was given a most important rôle, von Helmholtz [4] stated: "One can indeed thus explain the increased convexity of the anterior surface of the lens which Cramer has observed." Then he adds his objection that "through the hydrostatic pressure exerted on the posterior surface and the edges of the lens, the latter cannot well become thicker in its axial diameter; such pressure would tend to bow forward the equatorial plane of the lens and thus make the posterior surface flatter." The fact that the vitreous body has definite structure with marked significance for its probable influence on the form of the lens during accommodation was demonstrated by an honored member of this section, Park Lewis,[23] eleven years ago. It cannot be stated too emphatically, for it is often overlooked, that these two structures, vitreous and lens, may be made to react effectively the one against the other within the eyeball without increase of intra-ocular tension as long as they are surrounded by intercommunicating spaces and there is no increase in intra-ocular contents. Because they react as tissues and not within the narrow limits of "hydrostatic pressure" the mechanism with resulting changes in outline of the lens has even been demonstrated in animals' eyes that have been bisected.

Regarding the anatomy of the vitreous, the following items are selected from E. V. L. Brown's [14] excellent translation of Salzmann's "Anatomy and Histology of the Human Eyeball": "The vitreous as a whole has the form of a sphere flattened sagitally and marked in front by a round della. The della, fossa patellaris, is the negative of the posterior surface of the lens to which it is opposed. The transition from the fossa patellaris over into the outer convex surface of the vitreous presents a low wall on the back of which the posterior half of the corona ciliaris lies in undisturbed topographic relations and receives the shallow radial impressions of the ciliary processes." The convex anterior aspect of this wall of vitreous which surrounds the patellar fossa impinges on the periphery of the posterior lens surface.

Where the vitreous adjoins the lens, "firm union" is found "in the form of a ring of 8 or 9 mm. diameter concentric with the lens

22. Cramer and Donders, quoted by von Helmholtz (footnote 4).

23. Lewis, Park: Focal Adjustment in Aphakic Eye, Tr. Am. Acad. Ophth., 1920, p. 182.

border; here lies the ligamentum hyaloideo-capsulare described by Wieger." [24]

"The portion of the anterior surface of the vitreous lying inside this ring is not grown to the lens but can easily be drawn away as soon as the resistance of the ligamentum hyaloideo-capsulare has been overcome. A capillary space lies between it and the lens, the postlenticular space of Berger."

"In the fresh state the vitreous presents a completely transparent entirely colorless mass of jelly-like but firm consistency. The vitreous exceeds all of the other refracting media of the eye in transparency with the exception of the aqueous. Moreover, the vitreous maintains this transparency a long time after death (even in a weak formaldehyde solution); it merely becomes thready and of lessened consistency. Even in this condition the microscopic examination does not bring out the least trace of a structure in the vitreous; and so it is conceivable that in earlier periods, when none of the modern histologic aids were available, one did not understand how to begin to study the vitreous, and that the most varied views concerning its structure were expressed. Indeed, even the existence of such a structure was denied."

"That it must, however, possess such is evident from the fact that it has a form and consistency of its own; its elements do not flow apart over its supporting base, it can be weighed," etc. (Virchow [25]).

It must be conceded that if there is a mechanism by which this firm gelatinous vitreous body can be pressed against a lens with a mushy cortex in the periphery and an unyielding nucleus at its center, certain changes are likely to occur in the form of such a lens.

One cannot gainsay the probability that, if the convex anterior segment of the vitreous that surrounds the fossa patellaris is pressed against the equatorial zone of the lens, the soft cortex of the periphery of the lens will be pushed forward and axipetally, and increased convexity of the anterior surface will result.

As a matter of fact there is anatomic and experimental evidence that the anterior segment of the vitreous must be and actually is drawn against the lens in accommodation. But as these facts seemed contradictory to the general scheme of relaxation postulated by the accepted theory, a natural tendency developed to disregard or evade them and sometimes, by much involved explanations, to indicate their irrelevance.

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24. Wieger: Ueber den Canalis petiti und ein Ligamentum hyaloideo-capsulare, Inaug. Diss., Strassburg, 1883, quoted by Salzmann.

25. Virchow, H.: Facher, Zapfen, Leiste, Polster, Gefässe im Glaskörperraum von Wirbeltieren, in Merkel and Bonnet: Ergebn. d. Anat. u. Entwcklngsgesch., Wiesb., 1900, vol. 10; quoted by Salzmann.

I find, for example, that while reference is made repeatedly by certain writers to the proof submitted by Hensen and Voelckers [11] of the advance of the choroid in response to contraction of the ciliary muscle, an eloquent silence is maintained regarding their equally positive proof of a forward movement of the vitreous. Hensen and Voelckers state that "after removing the lens, the vitreous body bulges somewhat convexly forward. If now the accommodation is allowed to play, one sees how the saucer-shaped depression bulges strongly forward and upon cessation of the stimulation rapidly goes back." They even add, "This experiment is especially elegant"; showing how profoundly the observers were impressed by it. In their experimental search to locate the posterior attachment of the ciliary muscle, they state: "After we had completely bisected the globe, we observed that, with excitation of the ciliary nerves, that segment of the vitreous body nearest the lens bulged forward while the periphery of the vitreous next to the sclera sank inward."

To evade the obvious deductions from these observations by Hensen and Voelckers of forward movement of the vitreous, certain writers emphasize the difference between dogs' eyes and human eyes in the dioptric range of accommodative power.

The results that I obtained in experiments conducted at the Fondation d'ophtalmologique de Rothschild, Paris, in 1906, through the courtesy of Dr. Duclos seemed to show conclusively, on microscopic examination of cross-sections after fixation in solution of formaldehyde, that the vitreous body is drawn forward in the monkey's eye under physostigmine, completely filling a space found in front of the vitreous in the eyes under atropine. A similar difference was noted later by comparing the effect of physostigmine and atropine in sections of human eyes enucleated on account of extra-ocular cancer.

Finally, unmistakable evidence that the vitreous was pressed against the crystalline lens in the living human eye was found in observations on the effect of miotics on the position and movements of subluxated lenses. As these experiences have been recorded elsewhere in detail,[26] further reference here may be omitted.

As explained by Salzmann, Hensen and Voelckers,[11] like other earlier writers, did not recognize the actual structural capacity of the vitreous and assumed that its forward movement was due solely

26. Luedde, W. H.: Tr. XI Internat. Cong., Naples, 1909, p. 388; Indications for the Use of Pilocarpine in Dislocation of Crystalline Lens, Tr. Am. Ophth. Soc. **33**:71, 1925; Mechanism of Accommodation, Am. J. Ophth. **10**:15 (Jan.) 1927; Hensen and Voelckers' Experiments on the Mechanism of Accommodation: An Interpretation, Tr. Am. Ophth. Soc., 1927; Ber. d. ges. Physiol. **47**:301, 303, 1929.

to hydrostatic pressure on it by the traction of the choroid. Such hydrostatic pressure, if any, must be immeasurably evanescent owing to simultaneous opening of efferent channels from the eyeball by the coincident contraction of the ciliary muscle and of the sphincter of the iris. It is probably not a mere chance that reduction of intra-ocular tension accompanies myosis.

Manifestly, traction on the choroid will tend to stretch it as the cord of an arc of the overlying sclera. This would produce a rise of pressure within the vitreous were it not for a significant anatomic attachment, often overlooked, by which the peripheral anterior segment of the vitreous is simultaneously drawn forward so that it becomes merely a matter of rearrangement of intra-ocular contents.

The vitreous, according to Salzmann,[14] is fixed "most firmly, however, at the ora serrata and to the ciliary epithelium in a zone some 1.5 mm. broad immediately adjacent to the ora serrata." Salzmann emphasizes this interesting anatomic point by adding: "When the vitreous draws together under the influence of fixation and hardening fluids, when under pathologic relations it is shrunken down to a minimum, it clings at this point. Even severe injuries do not tear away the living vitreous in this situation, and when it is torn from it part of the ciliary epithelium goes with it, and the end of the retina loses its attachment. Since, furthermore, this zone is of significance in respects other than purely anatomic, it may be justifiable to give it a special name, and I would call it the base of the vitreous."

In view of this direct attachment, only a fact defying fancy could deny the probability of a general forward movement of the anterior segment of the vitreous more especially at its periphery as soon as contraction of the ciliary muscle occurs.

That this must mean movement of structural tissue and not mere hydrostatic transfer of pressure is demonstrated by the experiment of Heine [27] in the case of a freshly enucleated child's eye which showed that the mechanism of accommodation went on unhindered in spite of a scleral window, while the vitreous humor that welled up showed no corresponding movement. Beer, quoted by Hess,[10] obtained a similar result with a monkey's eye after making an opening through the sclera at the posterior pole. Hess concludes from these experiments that the intra-ocular pressure in the vitreous humor equals zero ("der Glaskoerperdruck also = 0 war"), which reminds one of the careless expression that "the patient has no temperature" when it is normal.

When the final stage of relaxation of the suspensory fibers of the zonule is reached, owing to concentric contraction of their support-

27. Heine: Ein Versuch über Akkommodation und intraokulären Druck am ueberlebenden Kinderauge, Arch. f. Ophth. **60**:448, 1905, quoted by Gullstrand.

ing base, the tense approximation of the vitreous against the lens need in no wise be lessened. The vitreous is held against the lens by two factors: (*a*) the ligamentum hyaloideo-capsulare—a firm anatomic union—and (*b*) the sustained contraction of the ciliary muscle through its traction on the "base of the vitreous." When the lens at this last stage of accommodation responds to gravity, it does not lose its anatomic attachment to the vitreous. It must carry the anterior segment of the vitreous with it. That is why the lens "trembles" or quivers when the eye makes jerking movements, just as a glass bead would tremble if attached to a mass of jelly when the plate on which the latter rests is shaken.

It is a well known clinical fact that the secondary movements of the lens at this last stage of accommodation are notably different from those of completely detached lenses.

Therefore, as long as the lens is not released from its attachment to the vitreous, it becomes mere idle speculation to say "The mobility of the lens under the great strain of accommodation proves unequivocally that there is no difference of pressure on its two surfaces in the accommodating eye; whereas in the passive state a slight difference of pressure is possible corresponding to the tension of the zonule" (Gullstrand [13]).

With the aqueous humor bathing the anterior surface of the lens and a firm ring-shaped attachment to the vitreous posteriorly, the impact against, and the restraint on the lens cannot be quite the same on the two surfaces even if intra-ocular pressure is unchanged. One must reckon with the restraint which the mass of the vitreous necessarily imposes on the lens through its constant attachment around its posterior surface.

Von Pflugk's [28] photographs of frozen sections of eyes of birds and monkeys show changes in the form of the lens in accommodation in entire accord with what might be expected if the vitreous were pressed against the lens. After comparison of the outlines of the lenses of monkeys' eyes under physostigmine and atropine with those of the lenses left in situ when no drugs are used and with those in which all zonular restraints are removed, von Pflugk concludes that the lens with increased accommodation departs more and more from the form postulated by von Helmholtz for the accommodated lens.

Von Pflugk, indeed, finds that monkeys' lenses, when the zonule is completely severed, become more spherical, thus confirming what Dalen [29] observed on a dead human eye, but the accommodated lens is thinner

28. von Pflugk: Ueber die Akkommodation des Auges der Taube nebst Bemerkungen ueber die Akkommodation des Affen und des Menschen, 1906.

29. Dalen, quoted by Gullstrand (footnote 13).

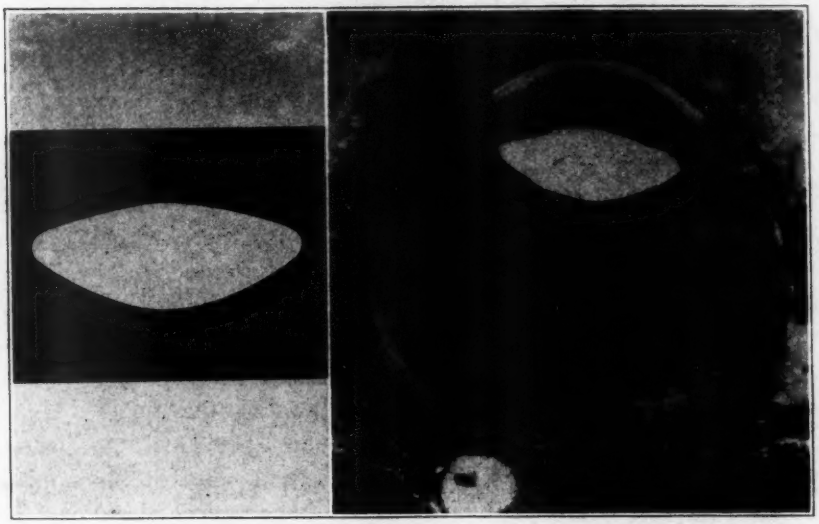

Fig. 2.—Frozen section of monkey's eye under atropine. Figs. 2 to 5 were furnished by Professor von Pflugk.

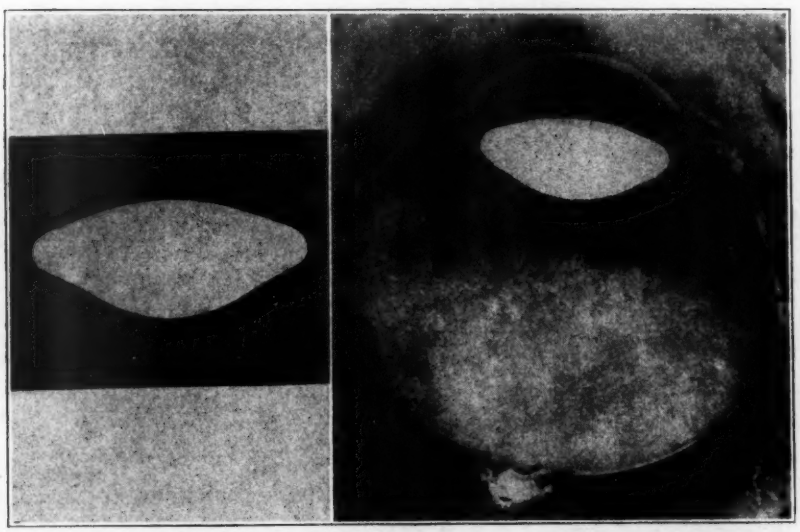

Fig. 3.—Frozen section of monkey's eye under ordinary simple muscle tone without any drug effect.

at the equator with a corresponding lengthening of the axis. There is a definite flattening if not actual indentation at the periphery on both anterior and posterior surfaces.

Von Hess,[30] in an address to this section in June, 1907, stated his attitude toward these experiments as follows: "When I read these papers it seemed to me very unlikely that these results could be correct; one of my assistants, Dr. Fischer,[31] repeated the experiments of von Pflugk on pigeons, with liquefied air, and he found that the freezing method is not at all suitable for the purpose."

Fischer varied the conditions of this investigation, so that direct comparison of his results with those of von Pflugk becomes difficult if not impossible. It is frankly open to question whether Fischer's choice of a more rapid method of freezing and of leaving the eyeball in the orbit and then freezing the whole head of the pigeon, instead of the more gradual and uniform application of the cold to the eye alone after speedy enucleation, may not be responsible for the constant recurrence of the artefacts which von Pflugk successfully avoided. Furthermore, it is manifestly unfair scientifically to compare the unretouched photographs of sections furnished by von Pflugk with the sketches drawn by hand regardless of the reliability of the draftsman. Fischer states that the sharply defined lens pictures were immediately measured by the university draftsman with the help of a magnifying loupe and then drawn with double enlargement. He adds that he refrained from the use of photographs because the latter did not give the desired sharpness of details. It is unfortunate that Fischer did not resort to improvement of photographic technic instead of clever draftsmanship. As it now stands, his evidence must be regarded as inconclusive.

Fischer used only one monkey, instilling atropine, 5 per cent, in the right eye and physostigmine, 1 per cent, in the left. That method also is open to question if one is trying to secure maximum effects for demonstration, for the drugs are antagonistic.

Fischer reported that under chloroform the right eye showed maximum dilatation while the left had only moderate myosis. He continues, "After decapitation, while freezing in liquid air was in process, lessening of the mydriasis (right) and variations apparently related to the temperature, showing decrease or increase in myosis of the physostigminized eye, occurred so that its pupil became at times larger than that of the atropinized eye."

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30. von Hess, Carl: Modern Views on the Physiology and Pathology of Accommodation, J. A. M. A. **49**:230 (July 20) 1907.

31. Fischer, F.: Ueber Fixierung der Linsen Form mittels der Gefrier-Methode, Arch. f. Augenh. **56**:342, 1907.

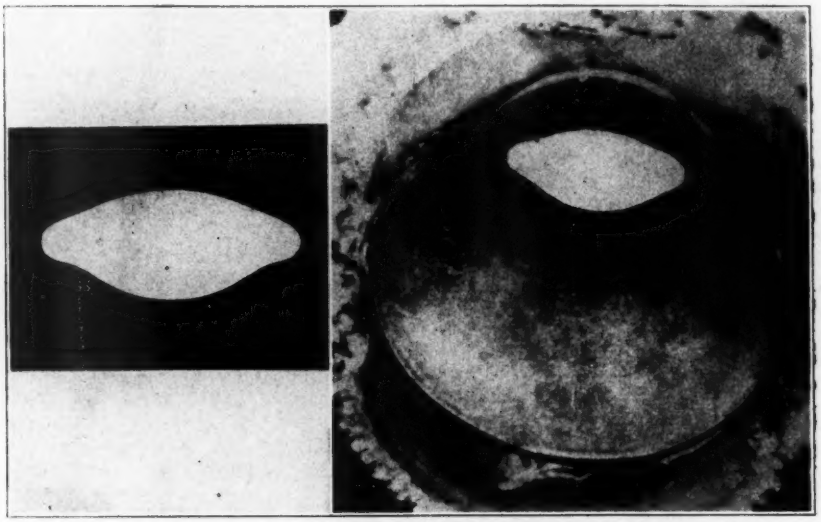

Fig. 4.—Frozen section of monkey's eye under physostigmine.

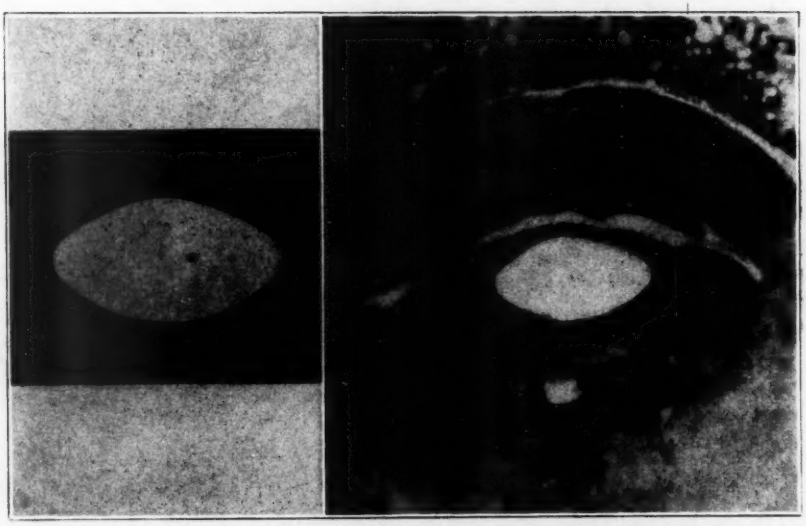

Fig. 5.—Frozen section of monkey's eye after all attachments of crystalline lens have been severed, the eyeball has been bisected, and then all parts have been loosely placed together before freezing, thus showing the so-called ground form.

Fischer's drawings of these two eyes are reproduced in figures 7 and 8. The left, in spite of distortion, shows evidence of what von Pflugk had demonstrated by photographs. Fischer failed to repeat his experiments on monkeys and thus eliminate possible errors in technic. Von Pflugk used five monkeys. His report, therefore, must

Fig. 6.—Outlines of monkey's eyes; *A*, under atropine; *B*, under physostigmine; drawn from frozen sections. Photostat from original by Fischer.

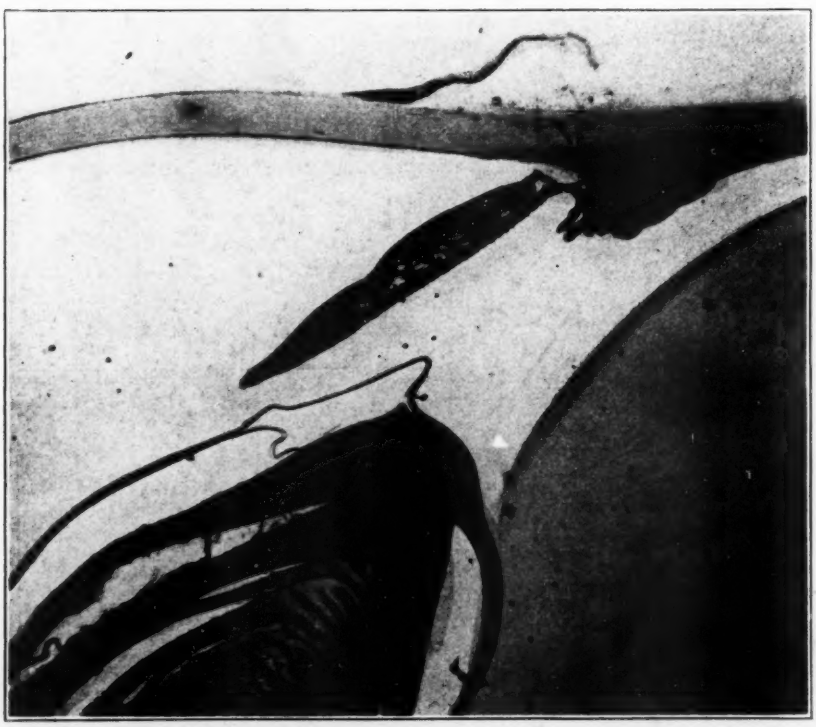

Fig. 7.—Ciliary body, iris and adjacent structures of monkey's eye under atropine. Attention is directed to the open space between limiting membrane of vitreous and ciliary body, zonula, and equator of lens.

be accepted unless more competent evidence can be brought forth to disprove it.

Fischer's critical comment concerning the lack of myosis shown in von Pflugk's photograph of a monkey's eye under physostigmine is partially answered by his own experience as already recorded. The

variations in myosis and mydriasis which he noticed while freezing the head of the monkey, which he attributed to evident variations in the effect of the cold, may have been caused by irritation or suppression of the sympathetic enervation of the dilatator in its relation to the parasympathetic control of the sphincter pupillae.

In a series that included the eyes of four monkeys and several human eyes, I likewise encountered loss of myosis, which was reported in 1909 as follows:

> The best specimen of an eserinized eye (in a monkey) was obtained by instilling the eserine solution repeatedly in the conjunctival sac until the animal died with the characteristic symptoms of eserine poisoning. In all other cases, in which general anesthesia was employed, the visible effect of the drug passed off, in a great measure or entirely, during the progress of the inhalation. In one case, of a child in whose eye the eserine could be used only during about an hour just before the operation, eserine was added to the fixing solution in the hope of possible further effect.

More recently, better results were obtained by immersing the enucleated eye in a solution of physostigmine for several minutes before fixation.

Gullstrand [13] is less definite with reference to the results presented by von Pflugk. He states, "However, the value of such experiments for purposes of demonstration should not be very highly estimated, since the action of forces developed by the freezing cannot be overlooked," but fails to tell just how its value should be assessed.

Gullstrand dismisses the subject by saying that "the mechanism of accommodation of the eye of a bird is essentially different from that of a human eye." As he makes no reference to it, Gullstrand apparently overlooked von Pflugk's report on monkey's eyes, which is an outstanding feature because it indicates that there is no essential difference in the outline of the accommodated lens in birds and in monkeys.

As for the difference in principle between the accommodative mechanism of the eyes of birds and of mammals for which Hess [10] contends, it is Ovio [8] who refers to Hess's own observations on the eyes of the otter, which show remarkable adaptation to the special demand for marked increase in refraction when seeking its food under water. A special strong musculature of the iris is developed which can exercise a certain compression on the periphery of the anterior surface of the lens, thus causing the central part of the same surface to be projected forward through the pupil with greater convexity. That mechanism is practically identical with the one found in birds' eyes and, in addition, as if nature intended to call attention to its birdlike character, the eye of the otter [32] is endowed with a nictitating membrane. Cramer's

32. Otter, in New International Encyclopedia **15**, 1911.

experiment on the iris of a young seal, reported by von Helmholtz,[4] indicates a similar adaptation in an under water mammal.

Zeeman [33] found doubling of the image of the posterior lens surface during active accommodation at the periphery in human eyes. It was not found in all cases but was very definite in some. The obvious explanation is a marked modification in the curvature of the posterior surface at its periphery similar to what von Pflugk had demonstrated in monkeys' eyes. Zeeman was careful in his report to distinguish between the double image from the posterior surface incident to active

Fig. 8.—Ciliary body, iris and adjacent structures of eye of monkey killed by physostigmine poisoning after repeated frequent instillations into the conjunctival sac. Attention is directed to the closure of the space noted in figure 7; also to the thickening of the ciliary body incident to contraction of the ciliary muscle. The apex of the ciliary body is thus projected inward and the diameter of the ciliary ring (the "corona ciliaris" to which the suspensory fibers of the zonula are attached) is decreased, relaxing the suspensory fibers and permitting the whole lens to drop in response to gravity or tremble with ocular movements when a "certain stage" of accommodation is reached. At the same time the vitreous body is pressed against the equator of the lens with sufficient force to cause the increased axial convexity.

33. Zeeman, W. P. C.: Ueber die Form der hinteren Linsenflaeche, Klin. Monatsbl. f. Augenh. **46**:83, 1908.

accommodation and the pseudo doubling due to variations in density of different layers of the lens, but his observations are dismissed by Gullstrand because this phenomenon may be observed in many senile lenses by looking in a direction nearly along the equator of the core. Gullstrand's apparent confusion of the static phenomenon of senile lenses with observation made during active accommodation tends to make his rejection less convincing.

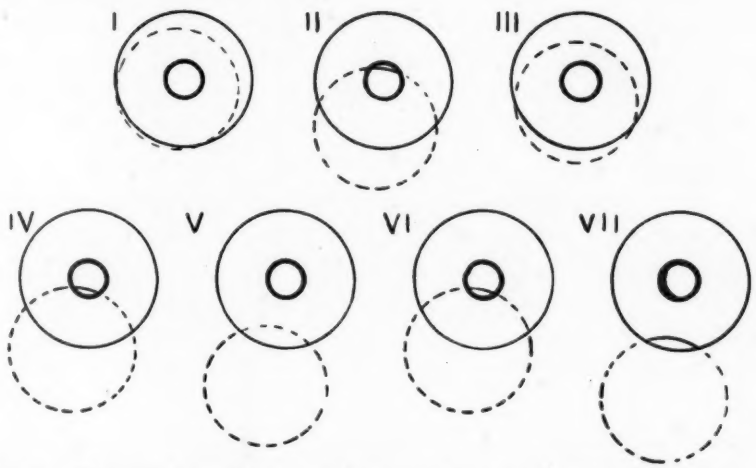

Fig. 9.—Changes in position of subluxated lens under pilocarpine: I, primary position of lens; II, after pilocarpine instillations for ten days; III, pilocarpine suspended one week; IV, after ten months' daily instillation of pilocarpine; V, after fifteen months of pilocarpine; VI, pilocarpine omitted for two days; VII, four days after resuming pilocarpine instillations.

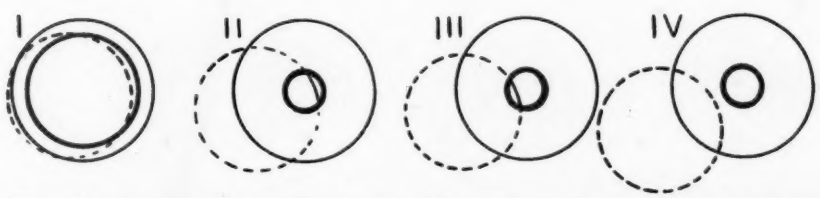

Fig. 10.—Changes of position of the subluxated lens in response to pilocarpine: I, position of lens with pupil dilated by homatropine; II, position twenty hours after instillation of pilocarpine, III, position of lens next day after repeated instillations of pilocarpine; IV, position after two weeks' instillation of pilocarpine twice daily.

Gullstrand rejects Tscherning's assumption that the result of the tension of the zonule is the formation of a "lenticonus anterior" by stating that it is "simply a false conclusion which he made from experiments that prove that in the extirpated lenses of animals a traction on the zonule may have this effect." Gullstrand, thereupon, reports

a crucial experiment of Einthoven [34] which confirms what Tscherning had reported, with a special reservation that seems to furnish a clue of unanticipated importance.

"Einthoven exposed the lens and zonule of a calf's eye from above and found that, by pulling with two forceps at opposite ends of a diameter, he could make the curvature of the anterior surface of the lens *increase* or decrease, according as he pulled *more backwards* or forwards, *respectively.*" The italics are not found in the original text but are used here to emphasize the correlation between increased convexity of the anterior surface of the lens and traction outward and backward on the zonule.

The same principle applied to the human eye, when the vitreous is pressed against the lens by forward traction of the ciliary muscle on the "base of the vitreous" (Salzmann), will so modify the static traction of the suspensory fibers of the zonule on the anterior capsule that they will also pull "backwards" and thereby increase the convexity of the anterior surface of the lens.

Perhaps it was an understanding of this probable effect of pressure of the vitreous against the lens that caused von Helmholtz to agree with Cramer and Donders that the increased convexity of the anterior surface might indeed be explained by the pressure of the vitreous against the lens.

Von Hess [17] reported that pulling on the zonule of the freshly enucleated eye of an ape produced decrease of convexity of the anterior surface of the lens. He does not specify the direction of his traction, but his description of the preparation of the eye makes it virtually certain that, in every instance, traction was directed outward and forward rather than backward.

Einthoven's experiment demonstrated that flattening might be expected on any pull outward or forward.

More than a third of a century ago, Tscherning [35] stated his belief that it made no real difference whether traction on the anterior capsule was by a direct pull outward due to contraction of the ciliary muscle or if the same zonular tension was produced by the vitreous being pressed against the lens. Tscherning's first notion of direct traction from the ciliary muscle could not be sustained by anatomic studies. The second phase of his opinion seems to be confirmed by Einthoven's experiment. Traction on the suspensory fibers of the anterior capsule should be precisely outward and backward when the vitreous is pressed against the lens. Such traction backward from the periphery of the

34. Einthoven: Die Akkommodation des menschlichen Auges, Ergebn. d. Physiol. **1**:680, 1902; quoted by Gullstrand.

35. Tscherning: Optique physiologique, 1898.

anterior capsule will tend to round off and broaden the equatorial margin of the lens while slightly lessening the transverse or equatorial diameter. This observation has been interpreted as potential proof for theoretical relaxation of the zonule during accommodation.

Attempts to determine definitely the detailed changes of form for the anterior and posterior lens surfaces by measurements of Purkinje's images have been disappointing by a lack of harmony in fact finding and in interpretation.

Lack of symmetry of the cornea, variations in the depth of the anterior chamber, indistinctness of image of the anterior lens surface, irregular variations in density of the lens substance, combine to confuse the detailed calculations on which research in physiologic optics must depend. When to this are added errors incident to obliquity in the direction of sources of illumination and in the alinement of instruments for observations of the posterior surface of the lens and its equator which are complicated further by variations in the size of the pupil and unsteadiness in fixation, there is little wonder that even the ablest observers have failed to obtain measurements that are uniform and constant.

Writing of measurements of the anterior surface, Gullstrand states, "There have been plenty of researches of these subjects, but, so far as the forward displacement of the anterior pole of the lens and the change of curvature of the anterior surface are concerned, the results can be considered only partially reliable."

Referring to measurements of the posterior surface, Gullstrand states that "the accommodative change of curvature of the posterior surface of the lens as here assumed is between the values found by Helmholtz and his pupils, on the one hand, but it is also between the values found by Tscherning and his pupils, on the other hand, and in each instance is nearer the value found by the teacher. But as to the reliability of this datum all that can be said is that with our present knowledge it is not possible to be more accurate."

Gullstrand [13] states of von Helmholtz that "Nowhere at all in his writings can the author find any intimation as to the probable form of the surfaces of the lens in the state of accommodation. This is not very surprising because, as already stated, there is no way of either calculating this form or estimating it. All that can be said about it is Helmholtz's own statement concerning the increase of curvature of the surfaces and of the thickness of the lens. As to the distribution of the increase of curvature over the various parts of the surface, and as to the possibility of a peripheral flattening during this process, nothing is stated, nor can anything be deduced from the relaxation of the zonule."

Such conclusions by Gullstrand, a great modern master of physiologic optics, offer little inducement to review in detail the many pages of mathematical formulas by which he fixes approximate values for his schematic eye or those by which he determines the relative values for his postulated extracapsular and intracapsular mechanism of accommodation. Finding by calculations based on the actual diameter of the lens at the greatest regular sphericity that it can yield less dioptric strength than is found to be present in accommodation, Gullstrand proposed an "intracapsular mechanism of accommodation" as a "mathematically necessary consequence of the change of form and of the increase of the refracting power. Also, in accordance with the histological structure of the lens, it demands an axipetal movement of the portions of the substance of the lens that are nearest to the points of attachment of the zonule, particularly on the anterior surface and that are contained within the greatest closed iso-indicial surface." This proposal is purely theoretical.

Tscherning pointed out that his demonstration of increased central convexity of the anterior surface of the lens ("anterior lenticonus") obviates the difficulty, just noted by Gullstrand, when simple sphericity of the lens is assumed according to Helmholtz. Gullstrand, however, protests that Tscherning's assumption of increased convexity at the central surfaces of the lens and relative flattening at the equator is "entirely without foundation," and then he adds, "Let it be stated once more that there are no proofs of its impossibility." Later Gullstrand admits, also, that "it is indeed quite possible that the peripheral portions of the anterior surface do become flatter, as Besio [36] thought he had proved"; although he does not consider it proved "because the approximate methods of calculation may involve considerable sources of error, and the methods of measurement were not very accurate anyhow."

Gullstrand thus eliminates extravagant criticism of Tscherning and there remains no incontrovertible evidence against the type of lens deformation in accommodation due to active external influence as was postulated by Schoen,[37] Tscherning and von Pflugk and, at a much earlier date, by Cramer and Donders.

It may be stated that there is no evidence that the iris or ciliary processes have any part in the mechanism of accommodation in man, except what may be contributed to the sharpness of the retinal image by a narrower pupillary opening.

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36. Besio, quoted by Gullstrand (footnote 13, p. 406).

37. Schoen: Der Accommodationsmechanismus, Arch. f. Phys., 1897.

In view of the widespread interest excited by the problem of sympathetic and parasympathetic enervation in general and special physiology, a more extended review of that relation to this mechanism is desirable. According to all available facts, it seems unlikely that the mechanical readjustments of the tissues incident to accommodation are modified by sympathetic enervation.

Don Joseph,[38] in 1921, demonstrated in the living calf's eye that the partially isolated sphincter of the iris can be relaxed directly by electrical stimulation of the cervical sympathetic. Thus, the iris sphincter which contracts in response to parasympathetic stimuli is relaxed, not by weakening of the parasympathetic, but by stimulation of the sympathetic. This is the so-called active relaxation ("aktive Erschlaffung"). Later, Poos,[39] whose investigations of the sympathetic enervation of the eye are noteworthy, confirmed Don Joseph's observations and secured similar results with stimulation of the sympathetic by direct application of epinephrine solution.

A similar control has been suggested for the ciliary muscle; i. e., that it may be contracted by the motor oculi, but relaxed or its contraction graduated by sympathetic enervation. So far as is known, its various muscular divisions are under the same control and contract or relax simultaneously.

Poos was able to produce direct contraction of isolated fibers of the dilatator muscle of the iris electrically and with epinephrine, and notes that it seems to possess in an unusual degree the "capacity for restraint" ("Sperrfaehigkeit") so characteristic for smooth muscular fibers. However, he reports that all attempts to secure similar results on muscle fiber preparations from the ciliary body of various animals have failed.

The experiments of Hess and Heine [40] indicated that the mechanism of accommodation depends on enervation of the ciliary muscle by the motor oculi. The proposition of Morat-Doyon [41] that the sympathetic adjusts the eye for distant vision while the motor oculi serves for near vision has not been verified, although rather suggestive drug reactions were obtained by Poos. Quite recently Hartgraves and Kronfeld [42] reached a conclusion of practical value that "the failure of the

38. Don Joseph: Am. J. Physiol. **55**:279, 1921.

39. Poos, F.: Zur Frage der sympathischen Innervation des Ziliarmuskels und ihre Bedeutung für die Akkommodation, Deutsche Ophth. Gesellsch., Heidelberg, 1927.

40. Hess and Heine: Arch. f. Ophth. **46**:2, 1898.

41. Morat-Doyon: Arch. f. Physiol., 1891, p. 512.

42. Hartgraves, Hallie; and Kronfeld, P. C.: The Synergistic Action of Atropine and of Epinephrine on the Intrinsic Muscles of the Eye, Arch. Ophth. **5**:212 (Feb.) 1931.

sympathomimetic drugs to increase the effect of atropine indicates strongly that the effect of the latter on the ciliary muscle cannot be increased by any method."

It is manifestly impossible to arrive at a reasonable explanation of the mechanism of accommodation by incorporating all the opinions that have been expressed on this subject. Some of them must be discarded. I make no claim that in this review all meritorious investigations of this problem have received adequate attention. Certain outstanding features of the controversy, only, have been discussed. If every divergent trail must be followed, we shall remain hopelessly lost in the forest of our fertile fancies.

On the other hand, it is relatively simple to follow the open pathway blazed by anatomic and physiologic facts, if we elect, as suggested by Dr. Millikan, to discard "all *a priori* conceptions." Even splendid suggestions made by great masters in bygone days, though they have served admirably for temporary theoretical explanations and may have stimulated scientific study, must be cast aside if they are not in accord with the simplest facts of today.

Strangely enough, only one preposterous assumption seems to stand in the way of a harmonious coordination of all facts concerning the mechanism of accommodation and that is the assignment of an impossible rôle to the physical property of matter called "elasticity." It is as foreign to the true meaning of the word "elastic" as it is to its usual function in biology to assume that elastic tissue is maintained in a state of deformity while at rest. If we reverse ourselves on this prevailing but manifestly false proposition, the alinement of authentically demonstrated facts becomes comparatively easy. We shall then find a mechanism which agrees in principle with all mechanisms that are known to exist in the animal kingdom. This universally constant principle is based on the fact that accommodative changes in the form or position of any crystalline lens are the result of extrinsic forces actively applied.

Between the accommodative mechanism of birds' and human eyes stand two modified interrelated factors. They are increased softness of the lens, and since the softer crystalline lens does not require it, there is no pressure of the base of the iris against the lens in the human eye. But nature does not hesitate to step over the line and give the more powerful mechanism to certain mammals for sight under water.

As the firm nucleus of the lens becomes larger and the soft cortex proportionately less in human eyes, accommodation is gradually abolished. One may speculate as to whether the arrangement in the bird's eye in addition to giving an apparently greater range of dioptric power

may obviate presbyopia and with it the danger of glaucoma present in the elderly human eye.

Certain formulas in physiologic optics built on the relaxation theory will require reconstruction. Although not able to reproduce even a small part of the wonderful edifice that has stood for so many decades, I, like any other passerby, may see the ledge of sand that underlies a section of its foundation where it has become exposed by the stress of time and elements.

Clinically, ophthalmology presents its quota of problems that wait more or less on a better understanding of the actual mechanism of accommodation; therefore an earnest consideration of this mechanism as an abstract problem seems fully warranted.

Metropolitan Building.

ABSTRACT OF DISCUSSION

DR. WALTER B. LANCASTER, Boston: The chief points at issue seem to be: (*a*) The cause of the increased curvature of the anterior surface of the lens in its central area. With this is associated an increase in thickness in the anteroposterior diameter of the lens and a reduction in the equatorial diameter. (*b*) The explanation of the relaxation of the fibers of the zonule which support the lens, a relaxation which becomes so great that the lens oscillates and sinks in extreme accommodation. (*c*) The action of the ciliary muscle. As to the cause of the change in form of the lens, it is recognized that in some of the lower animals and even in some mammals (as the otter) the lens changes its form by action of external forces (pressure of the iris). It is stated by Helmholtz that the molding force in mammal's eyes is exerted by the lens capsule. Tscherning, Luedde and others assert that the external force is applied to the lens by the vitreous and the zonular fibers. The lens capsule is elastic; the lens substance, except the core, is plastic. An elastic capsule under tension is not an uncommon phenomenon in nature. That the zonular fibers should be under slight tension seems not unnatural. They are in a sense a part of the capsule. Granted that the capsule has greater thickness in the zone near the equator and is thinner in the pupillary area (as Fincham has shown) than when left to itself, as, for example, in a subluxated lens, the capsule would so squeeze the lens as to give it a more spherical form, thicker in the axis, smaller equatorially, and much more convex in the pupillary area. The evidence that the lens left to itself, unacted on by external forces other than its own capsule, does take the more convex form demanded by accommodation seems to me conclusive, for it is the form taken by subluxated lenses and in dead eyes.

Next there is difference of opinion about the action of the ciliary muscle. The facts are that it is attached anteriorly near the canal of Schlemm. All agree that, when it contracts, its posterior end is pulled forward and the diameter of the ring it forms around the lens is reduced. If none of the needles inserted by Hensen and Voelckers into the ciliary body showed movement in accommodation, there is something requiring explanation, for it is absolutely certain that the posterior end of the ciliary muscle moves forward; otherwise it could not pull the choroid forward. If the posterior end of the ciliary body moves forward, the zonular fibers attached to it must have their posterior ends moved forward; that is, they must be relaxed. The observations of Basil Graves on the behavior of the empty capsule

in the living eye are very strong corroboration, and so of course are the observations of Hess and others of the oscillation and sinking of the lens in strong accommodation. Of course the lens would not be relaxed enough to oscillate in the *early* stages of accommodation, because the purpose of the relaxation is to permit the lens capsule to act, and while it is acting it takes up the slack of the zonular fibers. Thus it should require more accommodation to relax the zonule to the point of oscillation in young people than in presbyopia, and that has been observed.

The author asks us to believe that the vitreous in its anterior part is so rigid that when it is pulled against the posterior surface of the lens it acts not with uniform hydrostatic pressure but as a ring pressing on a zone near the equator of the lens. The vitreous is firmly attached to the wall at the ora serrata, called the base of the vitreous. When the ciliary muscle contracts, it pulls the choroid forward as much as 0.5 mm. in extreme contraction. Can one imagine that it pulls the anterior vitreous as a semirigid ring against the lens and that this is what squeezes the lens so as to make it change its shape?

DR. CHARLES A. BAHN, New Orleans: My discussion will be limited to cylindric or astigmatic accommodation, which is apparently of even greater importance than spherical accommodation. Does cylindric accommodation exist? 1. How otherwise can the disproportionally severe accommodative symptoms produced by slight uncomplicated astigmatic errors be explained, as well as the prompt relief that follows their proper correction? 2. Why do frequent and wide variations exist in both the amount and the axis of astigmatic corrections determined by suppressive thorough subjective and objective tests without cycloplegia? 3. Why is a cycloplegic necessary for the efficient refraction of more than one third of uncomplicated refractive errors, especially astigmatic, in patients under 45 years of age? This was shown in my investigations of several years ago. 4. Why can many persons change at will the relative blackness of the lines on the clock dial and other astigmatic charts? The understanding of these and many other ophthalmic problems is probably closely associated with cylindric accommodation. One of ophthalmology's greatest present needs is a practical test that will determine in the individual patient whether or not cycloplegia is specifically necessary for efficient refraction. At present, ophthalmologists are not able to distinguish, generally speaking, between the one patient who requires cycloplegic refraction and the two who do not. Such a test must be based on a more thorough understanding and accurate measurement of both spherical and cylindric accommodation. Cyclodamia, recently described by Dorland Smith, is partially based on this idea. The idea of cylindric accommodation is not new. Several investigators wrote about it shortly after the Helmholtz theory became generally known. Modern research methods, however, have changed greatly. Critical investigation and revision of the knowledge on this important subject are badly needed because present conceptions are largely based on studies made from twenty-five to seventy-five years ago. Dr. Luedde's interesting contribution emphasizes this fact.

DR. F. PARK LEWIS, Buffalo: I have no doubt that if Helmholtz were alive today no one would be more ready than he to take advantage of the more exact anatomic and physical knowledge now existing to revise his hypothesis made three quarters of a century ago concerning the mechanism of accommodation. As Dr. Luedde has pointed out, the lens is anterior to and not in the same plane with the ciliary body. The zonule has three major attachments, one at the chorioscleral juncture, retaining it in position; another in the substance of the anterior capsule and extending nearly to its center. It reaches back into the hyaloid membrane

almost to the optic nerve entrance. The traction which from their positions they must make could not produce the result which Helmholtz assumed. The accommodative center consists of a number of nuclei situated in the floor of the fourth ventricle. Fibers from it are distributed to the seventy or seventy-five processes. The branches of the third nerve respond to energy directed in two ways: to the two internal recti in convergence and accommodation, and to the internal rectus of the one eye and the external rectus of the other for the purpose of securing lateral motion. The ciliary muscle is not two muscles, but an entity, a part of which is circular and part of which is spiral and is inserted into the circular fibers. It was this fact that led the late Miles Standish, as he told me some years ago, to explain the Helmholtz theory in lecturing to his class in the Harvard University Medical School, although he always followed the explanation by saying that he did not believe the theory was true because it did not meet the anatomic requirements. It is logical to believe that energy directed toward the internal recti affects at the same time the inner or nasal and stronger portion of the ciliary muscle while, when the eyes are directed to the right or to the left side, the energy which is carried through the third nerve to the internal and external recti also energizes the nasal and the temporal ciliary nerves. The only logical conclusion is that the ciliary muscle acts coincidentally and in the same way as the rectus muscles but that the action on the ciliary muscle is segmental, for only in this way can a satisfactory explanation be given of full acuity of vision with marked corneal astigmatism. The contraction of the zonule produces pressure on the sides of the vitreous. The vitreous is incompressible. Therefore it can only push forward, flattening the sides of the lens, pressing the central portion and causing the increased curvature of the front of the lens. This requires no elasticity on the part of the lens and little muscular effort. It is the action of pressure on a plastic body governed by controllable muscular action which gives easily the exact curvature to produce the desired focus. This would seem to be the logical explanation of the mechanism of accommodation. In view of the fact that the helmholtzian hypothesis has been seriously questioned from many authoritative sources throughout the world, it would seem that the time has now come when the subject of accommodation should be restudied from the standpoint of physics, anatomy and physiology, and I hope the Executive Committee will take under advisement the desirability of instituting such studies during the coming year.

DR. PETER C. KRONFELD, Chicago: We must all admit that the theory of von Helmholtz is the easiest one to understand and the simplest one to teach. It is something that may be explained to lay people in a minute; but there is no question that the theory of von Helmholtz is not in accord with some of the basic facts of the anatomy of the human eye. The so-called elasticity of the lens cannot be demonstrated by any experimental methods. Therefore I am inclined to accept more complicated conceptions similar to those presented by Dr. Luedde. We ophthalmologists should try to study these problems in our patients. Some of our patients represent conditions which allow study and which might contribute to this problem. Just think of a young patient who has a small perforating injury of the cornea. One does a total iridectomy, and looking at this patient with the slit-lamp one sees the ciliary processes at the equator of the lens. One should take this patient and study him under the influence of atropine and compare the picture with one of the same eye made earlier under pilocarpine. I believe that the configuration of the so-called limiting membrane of the vitreous shows a different shape under atropine than under pilocarpine. Thus one can make up one's

mind whether the anterior segment of the vitreous plays an active part during accommodation or not.

Dr. W. H. Luedde, St. Louis: It is a matter of absolute evidence that one cannot deny that when the lens is entirely separated from its attachment the elastic fibers in its capsule do not prevent it from assuming a purely spherical form, so it is not the elastic fibers of the lens capsule which cause this peculiar form flattened at the equator. When the lens is separated from everything it does become a pure sphere, but that is not its accommodated outline. I agree with the point Dr. Lancaster brought out, that the accommodation surfaces as usually calculated are not sufficient to account for the actual amount of refraction present. There is some intracapsular movement, just what neither Dr. Lancaster nor I can say. That movement must be in connection with the external modeling. The fundamental principle which I would emphasize is that the lens in assuming accommodative power does it in response to external forces actively applied. That principle is sustained by every variety of accommodative mechanism found in the lower animals as well as by study of the human eye. Finally, in answer to Dr. Lancaster's suggestion that there may be relaxation of the zonule at the onset of accommodation as well as advance of the vitreous due to contraction of the ciliary muscle, it must be evident that if the zonule were relaxed when the anterior peripheral segment of the vitreous is drawn forward by traction on its basal attachment at the ora serrata, as has been demonstrated, then the periphery of the anterior chamber must become more shallow. Close observation has shown that this does not happen. So it appears that relaxation of the zonule is limited to the extreme or final stage when the accommodative modification of the outline of the lens has been completed. These problems and their practical relation to ophthalmic practice merit further study, as was so well brought out by the comments of Drs. Bahn, Lewis and Kronfeld.

THE CATARACT OF POSTOPERATIVE TETANY

WITH A REPORT OF THREE CASES *

C. S. O'BRIEN, M.D.
IOWA CITY

The association of cataract with tetany has been known for many years. Lens opacities of the lamellar type are frequently found in children or adults who have suffered from infantile tetany. However, in the rapidly developing lens opacities that are found occasionally in presenile persons, tetany as a cause probably has been and is often overlooked. Cataracts appear not only in the idiopathic type of tetany but also in the postoperative type. The present discussion is confined to the latter type.

Postoperative tetany results from interference with the function of the parathyroid glands. These glands of internal secretion, usually four in number, are quite small and are situated in close apposition to the posterior surface of the thyroid gland. They apparently control calcium metabolism. The postoperative type of the disease is due to removal of the parathyroids during thyroidectomy, in some instances to interference with the blood supply to the parathyroids or to their degeneration following scar formation after thyroidectomy.

Postoperative tetany or tetania strumipriva appears, as a rule, within forty-eight to seventy-two hours after thyroidectomy. The usual onset is with tingling and tonic spasms in both hands and arms. During the spasm the hands may assume a peculiar attitude known as obstetrician's hand. In severe cases cramps may be present also in the feet and legs, or they may even become generalized (epileptiform), and there may possibly be dyspnea, choking, difficulty in speech or cardiac involvement. In the severe forms death may ensue. The serum calcium of the blood is greatly reduced, and the phosphorus is increased. Usually the condition is recognized, and the administration of calcium and the hormone of the parathyroids controls most of the symptoms.

However, cataract may develop in the absence of other manifest symptoms and in spite of careful management. In mild forms of tetany, even though untreated, the symptoms may improve, and only a condition of latent tetany may remain. In latent tetany the diagnosis rests on the

* Submitted for publication, May 30, 1931.

* Read before the American Ophthalmological Society, Asheville, N. C., June 1, 1931.

* From the Department of Ophthalmology, State University of Iowa, College of Medicine.

demonstration of evidences of hyperexcitability of the peripheral nervous system, certain trophic changes in the epithelial structures and a low blood serum calcium combined with a high serum phosphorus. Erb's sign, hyperirritability of the nerves on application of the galvanic current, may be elicited. Chvostek's sign may be present; i. e., light tapping of the facial nerve over the area of the parotid gland produces twitchings of the muscles of the face. Trousseau's sign is sometimes present, i. e., muscular contractions of the forearm and hand on constriction of the arm. Trophic disturbances are frequently present; cataracts may develop and other epithelial structures may be affected; e. g., the hair may fall out, the nails may be lost, cavities in the teeth may develop and eczema or pigmentation of the skin may appear. The blood calcium is reduced and the phosphorus is increased. In a state of latent tetany there are usually no spasms whatsoever. The history of a goiter operation, followed for a time by transient and perhaps recurrent cramps, and the discovery of some or all of the findings mentioned, may be the only indication of the cause of rapidly developing lens opacities.

Logetschnikow [1] was apparently the first to assume that convulsions and presenile cataract might have an identical etiologic basis. As early as 1872 he reported fifteen cases of bilateral total soft cataracts, in patients from 16 to 37 years of age, in fourteen of whom spasms were present at the time of examination or in whom there was a history of general clonic muscle spasms preceding the deterioration in vision. While this observer did not mention tetany, in the light of present knowledge, it appears that at least some of his patients may have had this disease. Logetschnikow thought that the same condition which produced the spasms was also responsible for the cataracts.

In 1883, Schmidt-Rimpler [2] reported twenty-seven cases of bilateral total cataract in patients between the ages of 16 and 48 years, in six of whom there were muscle cramps.

Landsberg [3] was the first to recognize and report cataracts in postoperative tetany. In 1888 he reported bilateral cataracts in a 25 year old woman who had suffered from epileptiform attacks following removal of the thyroid. His examination was made two years after the thyroidectomy, and he found each lens changed into a grayish-white mass up to the anterior cortex. There was uveitis in one eye, and Landsberg thought that the cataract was secondary to the uveal inflammation which

1. Logetschnikow, S.: Zur Frage der Abhängigkeit der Cataractbildung von Nervenkrankheiten, Klin. Monatsbl. f. Augenh. **10**:351, 1872.

2. Schmidt-Rimpler, H.: Zur Aetiologie der Katarakt—Entwicklung in mittleren Lebensalter, Klin. Monatsbl. f. Augenh. **21**:181, 1883.

3. Landsberg, M.: Zur Aetiologie der Cataractbildung, Centralbl. f. prakt. Augenh. **12**:139, 1888.

had been set up by the convulsions. Operations were performed on the cataracts, and evidently recovery was uneventful.

According to Greppin,[4] the next to report such a case was Eiselsberg. In 1892 the latter reported cataracts in a 24 year old man who had tetany following thyroidectomy. The cataracts were removed one year after the goiter operation.

In 1897, Hoffmann [5] reported the cases of two patients with postoperative tetany, one of whom, a woman 36 years of age, had cataracts six months after a total thyroidectomy. An operation was performed on one eye, but there was no mention of postoperative complications. In the other patient cataracts were not mentioned, although the patient was observed for a period of four years after the thyroidectomy.

Schiller,[6] in 1899, reported bilateral cataracts in a woman aged 26, in whom, six months previously, there had been a second thyroidectomy followed by tetany.

In 1901, Westphal [7] observed a woman with bilateral cataracts complicating postoperative tetany. Her thyroid had been removed approximately four and a half years prior to the ocular examination.

Wagenmann,[8] in 1902, reported a case in a woman, aged 40 years, in whom bilateral cataracts developed rapidly following postoperative tetany.

In 1907, Possek [9] reported the case of a 29 year old woman in whom tetany followed thyroidectomy. A few months later cataract developed in each eye. In the same year Königstein [10] reported bilateral cataracts in a woman in whom tetany followed thyroidectomy. The diagnosis of cataract was made eight years after the goiter operation.

Purtscher,[11] in 1909, reported the case of a 26 year old woman in whom the vision became poor seven months after the onset of postoperative tetany. At the time of his examination, two years after

4. Greppin, M.: Ueber einen Fall von parathyreopriver Tetanie mit Katarakt-Bildung und Epithelkörperchentransplantation, Schweiz. med. Wchnschr. **52**:1260, 1922.

5. Hoffmann, J.: Weiterer Beitrag zur Lehre von der Tetanie, Deutsche Ztschr. f. Nervenh. **9**:278, 1897.

6. Schiller, A.: Ueber die Kropfoperationen an des Heidelberger Klinik in den Jahren 1888-1898, Beitr. z. klin. Chir. **24**:535, 1899.

7. Westphal, A.: Weiterer Beitrag zur Lehre von der Tetanie, Berl. klin. Wchnschr. **38**:849, 1901.

8. Wagenmann, quoted by Greppin (footnote 4).

9. Possek, R.: Schilddrüse und Auge, Klin. Monatsbl. f. Augenh. **45**:1, 1907.

10. Königstein: Setzungsberichte, Ophthalmologische Gesellschaft in Wien, Klin. Monatsbl. f. Augenh. **45**:268, 1907.

11. Purtscher, O.: Ueber Starrbildung nach Kropf-Operation, Centralbl. f. prakt. Augenh. **33**:97, 1909.

thyroidectomy, the cataracts were fully developed. An operation was performed, evidently without complications.

In 1911, Vogt [12] published a report of bilateral cataracts in a 39 year old woman who had been subject to tetany since a goiter operation twenty years previous to the time of his examination. There were spokelike opacities in each lens, especially in the central and posterior portions. Vogt thought the cataract due to toxins and cramps.

Jeremy,[13] in 1919, reported the case of a woman, aged 50, in whom bilateral cataracts complicated postoperative tetany. The patient's vision failed three or four months after the goiter operation. The right lens showed diffuse punctate opacities with little striation, whereas the left lens was diffusely opaque. Eiselsberg [14] cited a case reported in the same year by Hammerschmidt.[15] In this patient, a girl 17 years of age, cataracts were present twenty-two months after a second thyroidectomy complicated by tetany.

Jaeger,[16] in 1920, reported two cases of postoperative tetany with lens changes. The first case was that of a woman, aged 41, in whom cataracts were present six months after her second goiter operation. The second patient, a woman 42 years old, had a second goiter operation followed by tetany, and five years later had well developed cataracts.

In 1921, Eiselsberg [14] reported four cases of postoperative tetany cataract. The first case was a man, aged 35, in whom a diagnosis of cataract was made eleven years after the onset of postoperative tetany. The thyroid had been removed in the Billroth clinic. One cataract was removed, but the result was unsuccessful. Five years later the other cataract was successfully removed. The second patient, a woman 47 years of age, had both lobes of the thyroid removed. The operation was followed by tetany. Eleven years later she had cataracts. Both lenses were successfully removed. The third patient was a woman, 32 years old, who had severe tetany following thyroidectomy. Medication had little effect on the disease, and human parathyroid glands were transplanted into this patient, following which she improved. In spite of general improvement she had cataracts seven years after the thyroidectomy. Both lenses were removed, with good results. The fourth

12. Vogt, A.: Tetanie nach Strumektomie, Kor.-Bl. f. Schweiz. Artze **41**:695, 1911.

13. Jeremy, H. R.: Cataract Following Thyroidectomy, Brit. J. Ophth. **3**:315, 1919.

14. Eiselsberg, A.: Zur Behandlung der Tetania parathyreopriva, Arch. f klin. Chir. **118**:387, 1921.

15. Hammerschmidt, F.: Ueber Epithelkörperchen Transplantation bei postoperativer Tetanie, Dissert., Tübingen, 1919.

16. Jaeger, H.: Erfahrungen über den Wert der Epithelkörperüberpflanzung bei postoperativer Tetanie, Zentralbl. f. Chir. **47**:565, 1920.

case was that of a woman, aged 35, who had had two operations on the thyroid. One week after the second operation tetany set in, and a year later she complained of loss of vision. A diagnosis of complicated cataract in the right eye was made. Human parathyroid glands were implanted and her general symptoms improved, but one and one-half years later cataracts were present in both eyes. In the same year Pamperl [17] reported the case of a woman, aged 26, who had a second thyroidectomy followed by tetany; eight months later cataracts were removed. There is no note of complications following the cataract extraction.

In 1922, Van Lint [18] published the case of an 18 year old girl in whom cataracts appeared ten months after a thyroidectomy complicated by tetany. In the same year Sainton and Péron [19] reported the case of a woman, aged 35, in whom a diagnosis of bilateral cataracts was made four years after the onset of postoperative tetany. Also in 1922 Sidler-Huguenin [20] reported lens opacities in the eyes of a woman, aged 40, four months after a second goiter operation which was followed by tetany. In the same year Greppin [4] published a review of the German literature on this subject and reported one additional case. His patient was a woman, aged 37, who had two thyroid operations, the second of which was followed after four days by severe tetany. She was treated, but continued to have cramps. Within a month after operation the patient had visual complaints. Cataracts were diagnosed twenty months after the onset of tetany; the lenses were found to contain radial spoke-like opacities. About three and one-half years after the thyroidectomy each lens showed a dense central milky opacity.

Knüsel,[21] in 1924, reported four cases of postoperative tetany cataract in which examinations with the slit-lamp microscope were made. One patient, a woman aged 23, had a thyroidectomy seven years previous to the ocular examination. Although her vision was 6/6 in each eye, there were red and green crystals in the superficial layers of the lens in the right eye. In the periphery there were a few flecklike opacities. The second case was that of a woman, aged 34, who had tetany following a thyroidectomy three years before the ocular examina-

17. Pamperl, R.: Zur Entstehung und Behandlung der postoperativen Tetanie, Deutsche Ztschr. f. Chir. **161**:258, 1921.

18. Van Lint, A.: Cataracte après thyroïdectomie, Ann. et Bull. Soc. Roy. d. sc. **76-77**:36, 1922.

19. Sainton, R., and Péron, N.: Insuffisance parathyroïdienne chronique post-opératoire avec tétanie et troubles trophiques. Cataracte double opérée, Rev. neurol **38**:442, 1922.

20. Sidler-Huguenin: Stauungspapille bei Tetanie, Arch. f. Ophth. **107**:1, 1922.

21. Knüsel, O.: Das Spaltlampenbild der postoperativen Tetaniekatarakt, Arch. f. Ophth. **114**:636, 1924.

tion. Her vision was poor as a result of bilateral cataracts. The third patient, a woman 36 years of age, had tetany following a thyroidectomy two years previously. She had bilateral cataracts with vision of 0.3 in the right eye and 0.2 in the left. The fourth case was that of a woman, aged 24, who had a thyroidectomy followed by tetany eight months before the ocular examination. Examination with the slit-lamp microscope showed a few punctate opacities in the anterior cortex. At a second examination, fifteen months later, she had red and green crystals between the subcapsular zone and the adult nucleus. The lenses were similar to those in the first case. Knüsel differentiated three types of opacity: dustlike opacities, flaky opacities and crystalline masses. He felt that the posterior cortical changes were like those of any complicated cataract. According to this observer the situation is characteristic: The flaky opacities and crystals are confined to an area between the subcapsular line and the senile nucleus, but the dustlike opacities reach into the embryonal nucleus. The subcapsular line and central interval are always clear.

In 1925, Heine [22] reported two cases. The first patient, a woman, 39 years of age, had a thyroidectomy, followed by tetany, twenty years before cataracts were diagnosed. This patient had been seen for a conjunctivitis ten years after her goiter operation, at which time the vision was 6/6 in each eye. At the time the lens changes were discovered, the vision was 6/24 in the right eye and 4/24 in the left. Each lens showed a three-layer, lamellar type of cataract. Examination with the slit-lamp microscope revealed three distinct layers of diffuse milky opacity in the cortex, while under the anterior and posterior capsules there was a zone of fine granules. The second case was that of a 31 year old woman in whom cataracts appeared a few months after postoperative tetany. Nine months after the thyroidectomy her vision was 1/60 in the right eye and even less in the left. Heine thought that the cataracts did not show a special slit-lamp picture but that they had the appearance of a senile opacity, i.e., if the age of the patient was not considered. He felt that there were different slit-lamp appearances in tetany cataracts, and stated that the subcapsular opacity may be in one, two or three layers, or that a clear cortex may surround a milky nuclear opacity. Later in his article he stated that it is easy to distinguish tetany and myotonia cataracts from the senile types.

In 1926, Aub [23] reported the case of a girl, aged 19 years, in whom bilateral cataracts came to operation two years after a thyroidectomy,

22. Heine, L.: Ueber Tetanie und Myotonie Katarakte, Ztschr. f. Augenh. **55**:1, 1925.

23. Aub, J. C.: An Unusual End Result of Thyroidectomy, Boston M. & S. J. **194**:844, 1926.

followed by severe tetany. No mention was made of complications following the cataract extractions. The same year Kast [24] reported a series of six cases from the Vogt clinic. Slit-lamp studies were made in every patient. The first case was that of a woman, aged 28, whose lenses showed white shredlike subcapsular opacities made up of fine points; the capsule, cortex and nucleus were clear. The second case was that of a woman, 38 years old, who had tetany twelve years after thyroidectomy. Three years later there was some loss of vision, and examination revealed fine points of lens opacity; they occurred as radial streaks in the posterior cortex. Four months later there were fine opacities at the posterior pole. Three years later, in the right eye, the anterior cortex was still clear, the nucleus was slightly opaque and the chief opacity was situated at the posterior pole; the left eye showed some fine pointlike opacities in the anterior subcapsular zone and the other appearances of the right lens. Operation was done with no mention of complications. The third case was that of a woman, 48 years of age, who, three years after a thyroidectomy followed by tetany, complained of a cloud before her eyes. The lenses showed posterior shell-like opacities with green glittering points, and under the anterior capsule there were fine opacities and vacuoles. Two years later there were many subcapsular vacuoles and fine points of opacity. Water slits were present in the cortex; there was a nuclear opacity and a shell-like opacity at the posterior pole. Extraction was done, but there were evidently no complications. The fourth case was that of a patient, aged 42, who had had the last thyroid operation five years previously. There was partial loss of vision, and the right lens showed fine anterior subcapsular opacities, with a shell-like opacity at the posterior pole; there was a diffuse opacity of the left lens. Two years later extraction was done, evidently without complications. In the fifth case the age of the patient was 31 years. Three months after a goiter operation followed by tetany, vision was partially lost. Four years after the thyroidectomy there were fine subcapsular opacities and a shell-like opacity at the posterior pole. No mention was made of postoperative complications. In the sixth case, that of a patient aged 42 years, there were fine subcapsular opacities in the anterior and posterior portions of the lens, ten years after thyroidectomy. Kast believes that tetany cataract is typical, although it is similar to slowly developing diabetic cataract, and also to the lens opacities seen in ergotism and myotonic dystrophy. Typical of tetany cataract, according to Vogt, is the lessened anteroposterior diameter of the lens. Kast stated that this anteroposterior thinning and the fine, symmetrical, subcapsular opacities, more pronounced at the posterior pole, are typical of tetany cataract.

24. Kast, H.: Katarakt nach Strumektomie, Ztschr. f. Augenh. **59**:357, 1926.

Jacques,[25] in 1928, collected thirty-one cases from the German literature and one case from the English literature, and added two cases of his own. His first case was that of a woman, 23 years of age, in whom vision deteriorated a few months after thyroidectomy. The patient had tetany despite a serum calcium content of from 9 to 10.5 mg. per hundred cubic centimeters. There were diffuse granular opacities in both lenses, but they were especially dense in the center of the left lens. His second case was that of a woman, aged 27, who had two operations on the thyroid, the second of which was followed by tetany. One year later there were perinuclear opacities in both lenses. After another year the lenses were more opaque and swollen. He stated that this patient had mild tetany, but nevertheless the lens opacities developed. Also in 1928 Hunter[26] reported a case of postoperative tetany with cataracts. This patient, a woman aged 44 years, had had tetany following a goiter operation twenty-two years previously. The lenses were examined by Goulden who found superficial white, flaky opacities near the anterior and posterior capsules. There were also some multicolored crystals. The nucleus contained a few white powdery opacities.

Reeder,[27] in 1929, published the report of a case of bilateral cataracts in a woman aged 40, in whom a thyroidectomy had been performed eighteen months previously. She had tetany following removal of the thyroid. This patient had well advanced cortical cataracts. Vision was 6/60 in each eye. Both lenses were removed without complications.

Cole,[28] in 1930, reported the case of a woman, 34 years of age, who two years previously had a goiter operation followed by tetany. At the time of examination, fourteen months after operation, her vision was perception of hand movements at 1 foot (30.5 cm.). With the slit-lamp each lens showed a fairly generalized cataract, both central and nuclear. The opacities were in the shape of large pyramidal masses with the bases toward the equator. The fundus could not be seen. In 1930, Salvesen[29] reported five cases of postoperative tetany, in one of which he mentioned the presence of bilateral cataracts. This patient was a woman, 39 years of age, who had a thyroidectomy followed by tetany three and one-half years previously. Her vision had been failing for one year. Both eyes were subjected to operation, but no mention was made of complications.

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25. Jacques, L.: Cataract and Postoperative Tetany, Am. J. M. Sc. **175**:185, 1928.

26. Hunter, D.: A Case of Post-Operative Tetany, Proc. Roy. Soc. Med. **21**:1409, 1928.

27. Reeder, J. E.: Bilateral Cataract Following Thyroidectomy, Am. J. Ophth. **12**:122, 1929.

28. Cole, L. C.: Parathyroid Tetany and Cataract, Lancet **1**:13, 1930.

29. Salvesen, H. A.: Observations on Human Tetany, Acta med. Scandinav. **74**:13, 1930.

Postoperative tetany cataract is probably not so rare as might be indicated by the forty-two cases reported in the literature of the past forty-three years. That it does not occur in all cases of postoperative tetany is evident from a review of the literature. Many of the aforementioned authors reported cases with no mention of cataract. Recently Boothby, Haines and Pemberton [30] reported a series of eighty-eight cases of postoperative tetany with no indication that cataract had developed in any of the patients. It is difficult to estimate the frequency of cataract in this type of tetany, since the lens changes appear after several months and usually the patient with latent tetany has no symptoms and is not seen again by the operating surgeon. Another physician

TABLE 1.—*Results of Researches on Cataract in Experimental Postoperative Tetany*

Observer	Date	Animal	Cataracts	Comment
Erdheim [31]	1906	Rat	In 6 mo.	One animal only
Pfeiffer and Mayer (Mitt. a. d. Grenzgeb. d. Med. u. Chir. **18**: 377, 1907)	1907	Rats	.....	Worked with pregnant animals
Possek [9]	1907	Rats	In 3 or more mo.	Found microscopic changes in lens, ciliary body, iris and cornea
Adler and Thaler (Ztschr. f. Geburtsch. u. Gynäk. **62**: 194, 1908)	1908	Rats	In 4 mo.	Worked with pregnant animals
Edmunds [43]	1915	Dog	In 23 mo.	Dog kept alive with milk and calcium lactate
Luckhardt and Blumenstock [36]	1923	Dogs	In 8 or more mo.	
Hiroishi (Arch. f. Ophth. **113**: 381, 1924)	1924	Rats	In 6-35 days	Every completely parathyroidectomized animal which lived developed cataracts
Dragstedt, Sudan and Phillips [37]	1924	Dogs	In 3-6 mo.	

is consulted for the visual disturbances and there may be no association of the thyroidectomy and visual loss in the mind of either the patient or the physician. If the frequency of cataract, as a comparatively late finding in experimental postoperative tetany, is any indication of what happens in patients, it may be assumed that lens opacities are a frequent complication of the tetany that follows extirpation of the parathyroids during thyroidectomy. Erdheim,[31] in 1906, was the first to report cataracts as a part of the picture of experimental postoperative tetany. Following his lead many experimenters have reported similar findings. The results of a few of the researches along this line are given in table 1.

30. Boothby, W. M.; Haines, S. F., and Pemberton, J. de J.: Postoperative Parathyroid Insufficiency, Proc. Staff Meet., Mayo Clin. **5**:25, 1930; Am. J. M. Sc. **181**:81, 1931.

31. Erdheim, J.: Tetania parathyreopriva, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **16**:632, 1906.

REPORT OF CASES

Three cases of bilateral cataract, developing rapidly in association with postoperative tetany, are added to the cases already published. In two of these patients cataract extraction was performed; both had delayed spontaneous intra-ocular hemorrhage.

CASE 1.—Mrs. W. S., a white woman, aged 35, was admitted to the general hospital at the State University of Iowa on Oct. 27, 1930, complaining of deterioration of vision in both eyes.

History.—Ocular: The patient stated that her vision had always been excellent until two years before. She had never had any previous trouble with her eyes and had not worn glasses.

General: She had had the usual diseases of childhood. In July or August, 1925, she developed a goiter. Her heart rate was rapid, she was nervous and her eyes became prominent. She was treated but got no better, and in April, 1927, the goiter was removed. Two days after the operation she had tingling sensations in the hands, followed by cramps in the hands and arms. She was given calcium lactate, but continued to have occasional cramps during the convalescent period of two weeks in the hospital. After her return home she had many severe cramps, especially when she did not take the calcium lactate. Sometimes the cramps were also present in her feet and legs, and there were a few attacks in which she choked and was unable to speak. The attacks diminished in number and severity about one and one-half years ago, and since that time she had had little trouble except with her vision, even though she received no medication. There was no history of cataracts in the immediate family.

Present Illness.—In October, 1928 (one and one-half years after thyroidectomy), the patient noticed that objects appeared dim and blurred; this was more noticeable some days than others. She consulted an optometrist and was told that her vision was poor, but was provided with glasses, even though she felt that they did not improve the vision. Gradually vision decreased and in October, 1929 (two and one-half years after the goiter operation), her physician made a diagnosis of bilateral cataracts. Since then vision had diminished rapidly in both eyes. The patient felt well and thought her general health good. There were occasional mild tinglings in her hands but no cramps.

Examination.—The patient was examined on Oct. 27, 1930, three and one-half years after thyroidectomy. The results were:

Ocular: Both eyes were slightly proptosed and there was a gray reflex from the pupillary area in each eye, otherwise ordinary inspection revealed nothing pathologic.

In the right eye vision was light perception, with good projection. Through a dilated pupil the lens appeared cataractous throughout, but the cortex was not sufficiently opaque to obscure the central brownish reflex from the nucleus (fig. 1). With the ophthalmoscope only the gray lens was seen; there was no fundus reflex.

Through the slit-lamp microscope the cornea and anterior chamber appeared normal. There was slight atrophy of the iris. The lens opacity was composed of innumerable white points of different sizes, extending throughout the anterior cortex up to the anterior capsule; there were many subcapsular vacuoles. It was impossible to see beyond the anterior cortex.

In the left eye vision was perception of fingers at 0.3 meter. By gross inspection through a dilated pupil the lens appeared gray in the pupillary area, but the

Fig. 1 (case 1).—Right eye: mature tetany cataract.

Fig. 2 (case 1).—Left eye: immature tetany cataract.

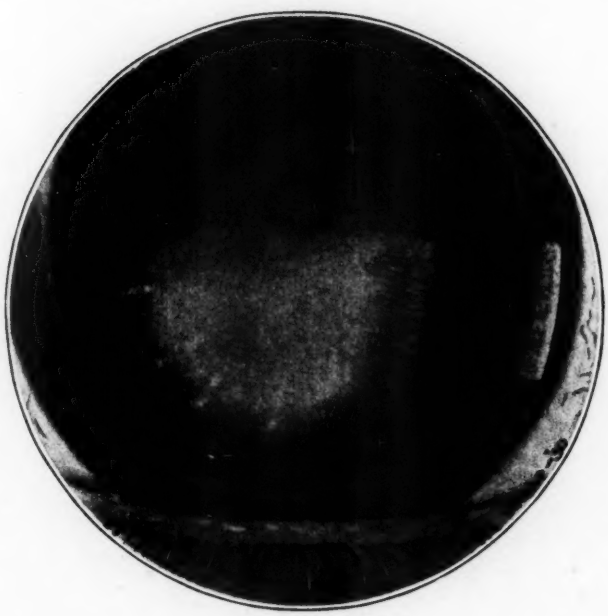

Fig. 4 (case 1).—Left eye: immature tetany cataract as seen with slit-lamp microscope (low power).

periphery was more or less clear (fig. 2). With an ophthalmoscope the pupillary area of the lens appeared diffusely darkened over a circular area about 6 mm. in diameter. The cortex, peripheral to that area, was finely granular, and in the posterior cortex the granules were collected into spokelike striae which extended centrally from the equator. There were some short fine striae in the anterior cortex (fig. 3).

Slit-lamp examination with the low power objective revealed nothing pathologic anterior to the lens. The lens showed many anterior and posterior subcapsular granular opacities which had a tendency to be arranged in a spokelike figure. The posterior opacities were more numerous. Surrounding the nucleus there was a thin layer of granular opacities which reminded one of a lamellar cataract (fig. 4). When viewed through the high power objective, a thin layer of cortex directly under the anterior capsule was seen to be filled with both finely granular and coarse irregular opacities of various sizes and shapes (fig. 5). There were many fine varicolored crystals among the opacities. Water slits and vacuoles were present under the capsule. There was a tendency for the finely granular opacities to form

Fig. 3 (case 1).—Left eye: immature tetany cataract as seen with ophthalmoscope.

subcapsular spokelike striae. Between the thin layer of anterior subcapsular opacities and the adult nucleus the cortex was clear, but immediately surrounding the nucleus there was a rather homogeneous opaque layer. The posterior portions of the nucleus could not be seen, but, looking to the side of the nucleus, the posterior subcapsular area appeared to be filled with opacities, similar to those in the anterior layers, except that they were more numerous and the spokelike striae were larger and more dense.

General: The patient was referred to the department of internal medicine where a diagnosis of postoperative hypoparathyroidism was made. The diagnosis was based on (1) a history of thyroidectomy, followed by cramps which were partially relieved by calcium lactate, (2) a history of failure of vision, (3) the presence of an operative scar on the neck, (4) cataracts, (5) a positive Chvostek's sign (cramps of the muscles of mastication on tapping the region of the facial nerve just in front of the tragus of the ear), (6) a positive Trousseau's sign (cramps of the hand and forearm on constriction of the arm), (7) a positive Erb's sign (hyperirritability of the nerves on application of the galvanic current) and (8) a low blood calcium. The hair was thin, but the nails and skin were normal. The blood pressure was 110 systolic and 80 diastolic.

Laboratory Findings and Metabolic Studies.—The Wassermann reaction was negative. Analysis of the blood showed: sugar, 118 mg. per hundred cubic centimeters; sugar tolerance after 50 Gm. of dextrose, highest concentration 165 mg. per hundred cubic centimeters at the one and one-half hour period; a return to normal at the two and one-half hour period. No sugar was found in the urine. Other findings were: uric acid, 5.3 mg. per hundred cubic centimeters; urea nitrogen, 14.0 mg.; creatinine, 1.0 mg.; calcium (serum), 5.5 mg.; phosphorus (serum), 6.7 mg.; carbon dioxide, 56 per cent by volume, and p_H, 7.60. The basal metabolic rate was —4.1 per cent. Roentgenograms showed no changes in any of the bones.

On November 12, the patient was transferred to the department of pediatrics where metabolic studies were made by Dr. J. D. Boyd and Genevieve Stearns. The serum calcium was low, varying between 5.8 and 6.2 mg. per hundred cubic centimeters, and the serum phosphorus high, varying between 4.7 and 6.7 mg.

The figures in table 2 give some idea of the results of blood analysis.

Fig. 5 (case 1).—Left eye: immature tetany cataract; slit-lamp appearance of anterior subcapsular opacities.

On Nov. 17, 1930, the spinal fluid calcium was 4.55 mg. and the phosphorus 1.78 mg. (practically normal). This patient had a metabolic study over a twenty-four hour period, and was found to have the intake and output shown in table 3.

This patient excreted in the urine only about 40 to 50 mg. of calcium daily, whereas a normal person on the same diet would have excreted from 150 to 250 mg. daily.

Treatment.—The patient was returned, on November 28, to the department of ophthalmology for operation. At that time she was receiving a high calcium diet, with 1½ quarts (1,419 cc.) of milk daily, 1 teaspoonful of calcium lactate five times daily and a tablespoonful of cod liver oil each day.

The right lens was extracted on November 28. There were no accidents during the operation; however, the incision appeared to be a bit deep into the limbus. Following peripheral iridotomy, an attempt was made to deliver the lens in the capsule, but the latter ruptured and an extracapsular extraction was made. Three

corneal sutures were placed and, at the completion of the operation, the eye appeared in good condition. No unusual bleeding occurred during the extraction.

This lens was examined by P. W. Salit. It weighed 0.073 Gm. and contained 85 mg. of calcium per hundred cubic centimeters of lens material.

At the first dressing, twenty-four hours after operation, the anterior chamber was formed and the iris was in normal position. The eye was dressed daily and appeared to be in excellent condition until December 3 (the fifth postoperative day), when the patient stated that she had had severe pain in the eye for several hours. The eye could not have been struck, since the metal shield that covered the dressing was in place. The dressings were blood-stained, and the cheek and lids were swollen. The anterior chamber was filled with blood and appeared almost black. The margins of the wound were bulging, even though the sutures

TABLE 2.—*Results of Blood Analysis*

Date	Serum Calcium, Mg. per 100 Cc.*	Serum Phosphorus, Mg. per 100 Cc.†
Nov. 10, 1930	5.8	6.7
Nov. 17, 1930	6.0	4.9
Nov. 24, 1930	6.2	4.7
Dec. 1, 1930	8.9‡	5.9
Dec. 21, 1930	9.2‡	3.5
Dec. 29, 1930	9.6‡	3.9
Feb. 7, 1931	6.8	6.7

* The normal calcium content of the blood serum is from 9.5 to 11 mg. per hundred cubic centimeters; that of the spinal fluid from 4.5 to 5.5 mg.

† The normal phosphorus content of the blood serum is from 3 to 4 mg. per hundred cubic centimeters; that of the spinal fluid from 1.6 to 2 mg.

‡ Parathyroid hormone given.

TABLE 3.—*Results of Metabolic Study*

	Calcium, Gm. in 24 Hr.	Phosphorus, Gm. in 24 Hr.
Intake (total)	2.184	2.288
Excretion (total)	2.062	2.125
Urine	0.052	1.110
Feces	2.010	1.015
Retention	0.122	0.163

remained intact, and blood was seeping through the wound. It appeared that the eye was lost, since the entire aqueous and vitreous were apparently filled with blood. Hot compresses, scopolamine hydrobromide and ethylmorphine hydrochloride were prescribed, and the blood in the anterior chamber disappeared slowly. On December 7 (four days after the hemorrhage), the patient could just distinguish light from an ordinary flashlight. The blood continued to be absorbed and later (December 15) it was apparent that she had some incarceration of the iris. The vitreous contained much blood. On December 19, she was placed on parathyroid hormone, 10 units, by hypodermic injection, twice a day. Her coagulation time on that date was 3½ minutes. While on parathyroid hormone the blood calcium rose to 9.6 mg. per hundred cubic centimeters and the phosphorus dropped to 3.6 mg. The blood appeared to be organizing in the vitreous. At the time of the patient's discharge from the hospital, on Jan. 16, 1931 (one and one-half months after operation), there were many large floaters in the anterior vitreous. She was advised to drink 1½ quarts of milk daily while at home, and was given ammonium chloride, 10 grains (0.65 cc.) by mouth, three times a day.

The patient returned to the hospital on February 25 (three months after the cataract extraction), and at that time ophthalmoscopic examination revealed a clear chamber with a few strands of tissue in the anterior vitreous. However, the pupillary area was clear and vision was 6/6— with a plus 14.00 diopter lens.

In view of the postoperative complication described, care was taken to administer parathyroid hormone, 10 units three times a day, prior to and after extraction of the lens from the other eye. In addition the patient was given milk, 1½ quarts daily, viosterol, 20 minims (1.23 Gm.) three times a day, and calcium lactate, 30 grains (1.94 Gm.) three times a day. After the patient had been on this regimen for a few days the blood calcium was 9.09 mg. per hundred cubic centimeters, the phosphorus 3.2 mg. and the carbon dioxide 59 per cent by volume. The left lens was extracted on March 9. There were no operative or postoperative accidents, and the eye was in excellent condition at the time of the patient's discharge, on March 23. This eye has not been refracted.

Comment.—In this patient, a woman aged 36, rapidly developing bilateral cataracts occurred in association with latent postoperative tetany. Vision began to fail six months after the goiter was removed. A diagnosis of cataracts was made by a physician two and one-half years after the operation. After another year the patient presented herself for treatment. She was found to have latent tetany, as evidenced by the history, the signs of hyperirritability of the peripheral nervous system and the finding of a low blood calcium associated with a high blood phosphorus. The patient was subjected to thorough metabolic studies and, after being placed on a high calcium intake, which was maintained throughout her stay in the hospital, she had the lens extracted from the right eye. Although the operation was without accident and the anterior chamber formed within twenty-four hours, there was a large spontaneous intra-ocular hemorrhage on the fifth postoperative day; the hemorrhage filled the anterior chamber and the anterior part of the vitreous and partially reopened the corneal wound. The hemorrhage disappeared slowly. It was thought that she would have little vision in the eye, but, after three months, vision was 6/6—with a plus 14.00 diopter lens. When the patient returned for a second cataract extraction she was given parathyroid hormone, in addition to a high calcium intake, and the postoperative course was normal. It appears that the parathyroid hormone may have had some bearing on the uncomplicated course following the second operation.

CASE 2.—Mrs. M. S., a white woman, aged 61, was admitted to the general hospital at the State University of Iowa on Nov. 15, 1930, with loss of vision as her only complaint.

History.—Ocular: There was no history of ocular disease, and vision had always been excellent until two and one-half years before, when the present trouble started. The patient had worn glasses since 35 years of age.

General: She had had the usual childhood diseases, except mumps. There was a history of head injury thirty-three years before. For many years the patient was afflicted with goiter; she was nervous, the eyes were prominent and she lost

weight. The goiter was removed in November, 1925. It was not until a few weeks after the thyroidectomy that she noticed a tingling sensation in her hands. This was followed by cramps in the hands and arms, whereupon calcium lactate was prescribed, but attacks of cramps continued for two years. The patient became mentally deranged, but recovered after eight months in a sanatorium. For the past two and three-fourths years there had been no symptoms, with the exception of occasional mild tingling in the hands and progressive loss of vision. There was no history of cataracts in the immediate family.

Present Illness.—The first symptoms of deteriorating vision were noticed in June, 1928 (two and one-half years after thyroidectomy). The patient consulted a physician, but was told that glasses were of no avail. Since that time vision had gradually failed. The patient felt well, except for occasional attacks of nervousness and slight tingling in the hands.

Examination.—The patient was examined on Nov. 15, 1930, five years after thyroidectomy. The results follow.

Ocular: There was bilateral exophthalmos, and a gray reflex was present in each pupil; otherwise gross inspection revealed nothing of pathologic importance.

In the right eye vision was light perception with projection. Through a dilated pupil the lens appeared completely opaque. No fundus reflex was obtained with the ophthalmoscope.

The slit-lamp picture, with a low power objective, was that of ordinary mature cataract. The cortex appeared gray, and the brownish nuclear discoloration was seen in the central area. Striae were made out in the anterior cortex; the posterior cortex was invisible. With the high power objective, the anterior subcapsular area showed coarsely granular, fleecy and striate opacities. Between the subcapsular opacities and the adult nucleus there was a semiclear area. One could not see beyond the anterior surface of the adult nucleus.

In the left eye vision was light perception and projection. The observations were the same as in the right eye.

General: A general medical examination was not made, but a diagnosis of postoperative hypoparathyroidism was made because of (1) a history of thyroidectomy followed by cramps, (2) a history of rapid failure of vision, (3) the presence of an operative scar on the neck, (4) cataracts, (5) and a low blood calcium content. The hair, nails and skin were normal. The blood pressure was 130 systolic and 80 diastolic.

Laboratory Findings and Metabolic Studies.—The Wassermann reaction was negative. Roentgenograms showed no variation in the density of the skull or bones of the hands; there was evidence of chronic osteoarthritis of both hands.

On November 24, the patient was referred to Dr. Boyd and Dr. Stearns for metabolic studies and preparation for operation. From the data in table 4 it is apparent that the chemical composition of the blood was altered.

The spinal fluid calcium was 4.44 mg. and the phosphorus 1.91 mg. per hundred cubic centimeters. A metabolic study, on November 27, yielded the results given in table 5.

This patient was excreting only small amounts of calcium in the urine (10 mg. daily), whereas a normal person on a similar diet would have excreted from 150 to 250 mg. daily.

Treatment.—The patient was placed on a high calcium diet, with 1½ quarts of milk daily, and calcium lactate was prescribed. On December 12, following a peripheral iridotomy, an intracapsular extraction of the lens was made on the left eye. Two conjunctival sutures were used in closing the wound. There were no accidents during the operation.

The lens was examined by P. W. Salit. It weighed 0.1191 Gm. and contained 40 mg. of calcium per hundred cubic centimeters.

The eye was dressed after twenty-four hours, and the anterior chamber was seen to be formed; there was no prolapse of the iris, and the eye appeared to be in excellent condition. Daily inspection of the eye showed normal healing until December 17 (the fifth postoperative day). During the night a spontaneous hemorrhage had filled the anterior chamber with blood; however, there was no breaking open of the wound as in case 1. It was felt that the hemorrhage was not due to a blow, for the metal shield had been in place since the previous dressing. On that date the clotting time of the blood was 1¾ minutes. In addition to the high calcium diet, parathyroid hormone, 10 units twice a day, was ordered. The hemorrhage disappeared entirely in about ten days, and the patient left the hospital on December 27, with a clear anterior chamber.

TABLE 4.—*Results of Blood Analysis*

	Serum Calcium, Mg. per 100 Cc.	Serum Phosphorus, Mg. per 100 Cc.
Nov. 24, 1930	6.4	5.42
Nov. 26, 1930	6.4	5.40
Nov. 28, 1930	5.4	6.66
Dec. 10, 1930	6.1	4.76
Dec. 21, 1930	8.2*	2.40

* Parathyroid hormone given.

TABLE 5.—*Results of Metabolic Study*

	Calcium, Gm. in 24 Hr.	Phosphorus, Gm. in 24 Hr.
Intake (total)	1.718	1.825
Excretion (total)	1.720	1.759
Urine	0.010	0.385
Feces	1.710	1.374
Retention	−0.002	0.066

On February 5 (six weeks later), the patient had 6/6 vision with a +5.50 diopters sphere ⌒ +8.50 cylinder, axis 10. The high astigmatism was not due to iris incarceration, since the pupil was perfectly circular, and there was no bulging in the wound area.

Comment.—In this patient, a woman aged 61, bilateral cataracts developed rather rapidly in association with a latent tetany which had followed thyroidectomy. The vision began to fail in both eyes two and one-half years after removal of the thyroid, and, at the end of a five year period, each lens showed mature cataract. That the patient had tetany was revealed by the history of attacks of tingling and cramps in the upper extremities and by the finding of a low serum calcium and a high serum phosphorus. Before removal of the cataract and during convalescence, she received a high calcium diet, large quantities of milk and calcium lactate. The operation was without accident, and the wound was closed within twenty-four hours after the operation, but on the

fifth postoperative day a spontaneous hemorrhage filled the anterior chamber. She was placed on parathyroid hormone immediately. The hemorrhage was absorbed rapidly, and six weeks later the vision, with proper correction, was 6/6.

Spontaneous intra-ocular hemorrhage is exceedingly rare after uncomplicated cataract extraction. The patients in both case 1 and case 2 were in the hospital at the same time, and the fact that each had a delayed spontaneous intra-ocular hemorrhage, following uncomplicated extraction of the lens, made it appear that the chemical changes produced in the body by the absence of parathyroid hormone may have had a bearing on the complication. According to Kast,[24] Vogt had two such experiences in a small series of similar cases. While neither of my patients had any permanent damage, I can well understand that, in some cases, the hemorrhage might be so great as to destroy vision. Had the wound in case 1 not been well sutured, it is felt that the eye would have been lost. Before performing an operation in such a case, it would be wise to supplement a high calcium diet with the administration of parathyroid hormone. It cannot be stated that such treatment will prevent hemorrhage, but it is believed that it will do so, since under those conditions the calcium and phosphorus can be made to approach more nearly normal concentrations.

CASE 3.—Miss M. M., a white woman, aged 36, was seen first on March 23, 1930. There were no visual complaints, but since that time the patient has been under observation for more than a year, and the development of bilateral cataracts has been and is being watched.

History.—There was no history of ocular disturbances. The patient had had measles and whooping cough in childhood. At the age of 12 years she first noticed an enlargement of the neck; this increased in size, but caused no symptoms aside from occasional choking spells associated with coughing. At the age of 22 years (in 1916) she had the right lobe of the thyroid removed. The growth remained stationary for a time, but in January, 1929, it began to enlarge rapidly. On September 24, the left lobe, isthmus and remainder of the right lobe of the thyroid were removed. At the time of operation the surgeon thought that he identified the parathyroid glands, and purposely did not disturb them. Three days after the operation there were tingling sensations in the hands and arms. The following day typical carpal spasms were present in the hands, and Chvostek's sign was positive. Calcium lactate and parathyroid extract were prescribed. After three days all signs of tetany had disappeared and the blood calcium was 7 mg. per hundred cubic centimeters. The medication was discontinued, and there was an immediate return of the tetany. The administration of calcium lactate and parathyroid extract again stopped the cramps, and the patient was discharged from the hospital on October 14. At that time her blood calcium was 8.7 mg. per hundred cubic centimeters. She was instructed to take calcium lactate, 20 grains (1.29 Gm.), three times a day at home.

The patient developed a psychosis in December, 1929, and also had typical attacks of tetany. She was placed on treatment and committed to a psychopathic

hospital. She recovered from the mental disturbance somewhat, and on Jan. 4, 1930, was sent to Dr. Boyd and Dr. Stearns for metabolic study.

No history of cataracts in the immediate family was obtainable. There were five cases of goiter in the family.

Present Illness.—No eye complaints were elicited. On admission to the metabolism ward the patient had numbness in the hands and feet, tetany and delirium. A diagnosis of hypothyroidism and hypoparathyroidism was made. The patient has been in the hospital for more than a year and has been studied and treated continually. She has had practically no signs of manifest tetany, except on rare occasions. When the calcium has been allowed to fall to unusually low concentration, there have been signs of mental disturbance. Her blood calcium has varied

TABLE 6.—*Results of Blood Analysis*

Date	Serum Calcium, Mg. per 100 Cc.	Serum Phosphorus, Mg. per 100 Cc.
Jan. 13, 1930	4.8	7.3
Jan. 21, 1930	6.7*	4.6
Feb. 8, 1930	9.0	3.0
Feb. 22, 1930	7.0	5.8
March 4, 1930	6.7	4.6
March 19, 1930	5.1	5.6
April 9, 1930	4.7	7.8
May 6, 1930	5.4	5.5
June 20, 1930	7.6	4.9
Sept. 29, 1930	6.0	6.2
Oct. 14, 1930	5.0	6.2
Oct. 16, 1930	4.8	6.2
Oct. 17, 1930	4.6	7.0
Oct. 29, 1930	5.7	6.3
Nov. 3, 1930	5.7	6.6
Dec. 27, 1930	5.1	4.8
Feb. 5, 1931	5.6	6.7

* Parathyroid hormone started.

TABLE 7.—*Results of Metabolism Study*

	Calcium, Gm. in 24 Hr.	Phosphorus, Gm. in 24 Hr.
Intake (total)	3.941*	2.365
Excretion (total)	3.978	2.325
Urine	0.028	0.735
Feces	3.950	1.590
Retention	—0.037	0.040

* Calcium lactate by mouth.

between 4.5 and 7 mg. per hundred cubic centimeters (except in one instance) and her phosphorus between 9 and 3 mg. In spite of treatment it has been impossible to maintain the blood calcium and phosphorus at normal levels.

From table 6 it may be seen that the chemical composition of the blood has remained altered, in spite of diligent treatment with parathyroid hormone, thyroid extract, viosterol, ammonium chloride, calcium chloride and a high calcium diet.

The spinal fluid calcium has been practically normal; it has varied between 3.9 and 5.7 mg. per hundred cubic centimeters. The phosphorus has been normal also, between 1.6 and 2 mg. per hundred cubic centimeters.

A metabolism study on Oct. 20, 1930, yielded the data given in table 7.

The urinary excretion of calcium while on a high intake was: Jan. 7, 1930, a trace; February 13, 0.002 Gm., and March 25, 0.017 Gm. (Normal excretion, on her intake, from 0.100 to 0.200 Gm. daily.)

In April, 1931, the p_H values of the blood varied between 7.36 and 7.40 and the carbon dioxide-combining power was from 62 to 68 per cent by volume. Such values were found even though ammonium chloride was discontinued. One would believe that in this patient there was no alkalosis.

The basal metabolic rate averaged —20 per cent until thyroid extract was prescribed. The patient has received thyroid extract, 10 grains daily, over a long period of time, and her basal rate has been from —5 to +3 per cent.

Roentgenograms showed the bones to be of normal density.

Examination of Eyes.—On March 23, 1930, the patient's eyes were examined by an experienced house physician, and the vision was found to be 6/6—2 in the right eye and 6/9+2 in the left. No pathologic process in the lens was seen with the ophthalmoscope at that time, but no examination with the slit-lamp microscope was made.

Fig. 6 (case 3).—Right eye: early tetany cataract; slit-lamp appearance of anterior subcapsular opacities.

On December 18, the following lens changes were seen: In each eye ophthalmoscopic examination revealed irregular, fine radiating streaks in both the peripheral and pupillary regions of the lens. With the slit-lamp microscope (low power objective) the right eye showed a thin layer of irregular, granular gray opacities immediately under the anterior and posterior capsules of the lens. The opacities were confined to a thin layer directly beneath the capsule. They were no more numerous posteriorly. A few congenital opacities were present in the fetal nucleus. The lens of the left eye had a similar appearance, except for the fact that the subcapsular opacities were more numerous in the anterior subcapsular area than in the posterior regions. With the high power objective and using a very fine slit, the opacities appeared to be directly under the capsule and were composed of irregular aggregations of small opaque granules.

On December 19, a sketch was made of the anterior subcapsular opacities in the right eye (fig. 6).

On March 6, 1931, another examination was made. There was some increase in the subcapsular opacities. Another sketch was made of the anterior subcapsular opacities at that time (fig. 7).

On April 23, the vision in the right eye was 6/9+2 and in the left eye 6/9+1. Another slit-lamp examination revealed an increase in the opacities, especially in the anterior subcortical zone. Green crystals were seen for the first time in the opaque areas. In addition, deeper cortical opacities were noted in both the anterior and posterior portions of each lens. No anteroposterior thinning was discernible. Particular attention was paid to the location of the anterior subcapsular opacities. They were directly under the capsule and not behind the anterior zone of discontinuity.

Comment.—In this patient, a woman aged 36, the development of bilateral postoperative tetany cataracts was observed. The patient had no spasms or other manifest signs of tetany during the period of cataract formation, but the serum calcium remained low and the phos-

Fig. 7 (case 3).—Right eye: appearance three months later than stage shown in figure 6.

phorus high despite treatment. The lens opacities were first observed as fine granular gray areas directly under the anterior and posterior capsules. No anteroposterior thinning of the lens could be determined. The cataracts progressed in spite of every known form of treatment.

COMMENT

Etiology.—Postoperative tetany cataracts are prone to occur in persons who have had more than one operation on the thyroid, since the parathyroids are more liable to be removed in such operations. The cause of cataracts in postoperative tetany is not yet known. As in certain other diseases there are theories but they have not been proved.

Logetschnikow [1] observed cataracts in association with convulsions and believed the two to have a common etiology. He did not feel that

the lens changes were caused by the spasms, as did Schmidt-Rimpler.[2] Landsberg [3] felt that the cataracts in his patient were the result of a uveitis which had been brought on by convulsions. Wettendorfer,[32] writing on the occurrence of cataract in juveniles with convulsions, stated that the opacities were due to the effect of ciliary muscle spasms on the lens epithelium. Peters [33] first thought that cramps in the ciliary muscles caused the lens changes, but later abandoned that theory and stated that toxins acting on the ciliary epithelium produced an increase in the protein and inorganic salt content of the aqueous which, in turn, affected the lens epithelium and brought on cataractous changes Westphal [7] did not agree with Peters and stated that Uhthoff and he felt that the convulsions and cataracts were due to the same basic cause. Zirm [34] could not understand how ciliary muscle spasms could cause cataract any more than cramps in the hands could be the cause of the changes in the fingernails. He believed the cataract to be the result of trophic changes in the ciliary epithelium. Zirm agreed in part with Peters, but thought that the cramps in the ciliary muscles and the cataracts were from the same cause. Pineles [35] did not think that ciliary muscle spasms produced cataracts, but believed that the lens changes were the result of "tetany poison." Possek [9] thought that degeneration of the capsular epithelium caused the lens changes. He studied a number of parathyroidectomized dogs, and found changes in the cornea, iris, ciliary body and lens. Jeremy [13] believed that in tetany there was a toxemia, uncontrolled by sufficient thyroid and parathyroid secretion, and that the toxin was the cause of lens opacities. Luckhardt [36] felt that the action of toxins on the lens epithelium produced the cataracts. Dragstedt [37] held the same belief. Greenwald [38] believed that, in the absence of parathyroid hormone, there was a deposit of calcium in the tissues, and that the cataract may have been due to the deposition of calcium phosphate in the lens. In his animals there were no cataracts unless phosphorus retention existed. He did not believe that a toxin

32. Wettendorfer, F.: Ein Beitrag zur Aetiologie des juvenilen Totalstarres, Wien. med. Wchnschr. **47**:470 and 1656, 1897.

33. Peters, A.: Weitere Beiträge zur Frage der Cataractbildung durch Tetanie, Ztschr. f. Augenh. **4**:337, 1900.

34. Zirm, E.: Zur Tetanie-Cataract, Arch. f. Augenh. **52**:184, 1905.

35. Pineles, F.: Gesellschaftsberichte, Ophthalmologische Gesellschaft in Wien, 1906, Zentralbl. f. Augenh. **30**:235, 1906.

36. Luckhardt, A. B., and Blumenstock, J.: Additional Observations on Completely Thyroparathyroidectomized Dogs, Am. J. Physiol. **63**:409, 1923.

37. Dragstedt, L. R.; Sudan, A. C., and Phillips, K.: Studies on the Pathogenesis of Tetany: IV. The Tetany of Oestrus, Pregnancy and Lactation, Am. J Physiol. **69**:477, 1924.

38. Greenwald, I.: Is There a Toxin in the Blood of Parathyroidectomized Dogs, J. Biol. Chem. **61**:33, 1924.

existed. Eiseman and Luckhardt [39] investigated the cause of cataract in tetany, but were unable to produce lens changes in dogs with artificially induced convulsions, depressed blood calcium content or increased blood phosphorus. Jacques [25] did not believe that the convulsions produced cataracts, but had no theory of his own. Salvesen [29] stated that cataracts may develop when the blood calcium is lower than 7 mg. per hundred cubic centimeters. Kirby [40] felt that tetany cataract came as a result of lowered calcium in the serum, aqueous and vitreous, with resultant electrochemical changes and disturbances in the equilibrium of the inorganic elements in the lens which caused changes in the labile colloidal solution of lens protein.

It seems improbable that convulsions are the cause of the lens changes in tetany, since other diseases, such as epilepsy, in which spasms occur produce no changes in the lens. I was able to watch the development of cataracts in one case in which no spasms occurred during the progress of the lens changes. Nor again does it seem that toxins, either by direct action on the lens epithelium or indirectly by action on the ciliary epithelium, produce the lens changes, since it is doubtful if such toxins exist in persons with tetany. Many investigators have found the ciliary epithelium normal in parathyroidectomized animals. The theory that calcium deposits in the lens are the cause of tetany cataract is not borne out when one realizes that ordinary senile cataracts contain comparatively large amounts of calcium (Burge,[41] Salit [42]). That there are disturbances in other epithelial structures (hair, nails and skin) is known, but when one states the cause to be a trophic disturbance the basic etiology is not explained.

It may be that there is a deficiency of calcium and an increase in phosphorus in the aqueous and vitreous. Since calcium may have to do with maintenance of colloidal solutions, such as the lens protein, a change in the protein might be expected following a decrease in the concentration of calcium in the surrounding fluids. However, if the aqueous is similar to the spinal fluid, a lowered calcium content would not be expected; neither would an increase in phosphorus be expected, since that of the spinal fluid is not greater than normal.

Again, the cataracts may be the result of a change in the p_H of the aqueous and vitreous. Tetany may be associated with an alkalosis, and

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39. Eiseman, C., and Luckhardt, A. B.: Mechanism of Cataract Formation in Thyroparathyroidectomized Dogs, Proc. Soc. Exper. Biol. & Med. **25**:6, 1927.

40. Kirby, D. B.: A Study of Calcium in Relation to Cataract, Tr. Am. Acad. Ophth., 1930, p. 89.

41. Burge, W. E.: Analyses of the Ash of the Normal and the Cataractous Lens, Arch. Ophth. **38**:447, 1909.

42. Salit, P. W.: Calcium Determinations on Cataractous Human Lenses, Am. J. Ophth. **13**:1072, 1930.

a prolonged change in the hydrogen ion concentration of the surrounding fluids would tend to produce changes in the lens protein. However, an alkalosis was not discovered at any time in my three cases.

Pathology.—In a parathyroidectomized dog studied by Edmunds [43] the lenses were examined microscopically by Coats. No changes were found in the lens epithelium, and evidences of cataract were most prominent in the deep cortex. Such findings are at variance with those of most observers, since it seems to be the rule that the first changes have occurred in the subcapsular zone. Kirby [40] cited the work of Siegrist and Goldmann who found the first changes to be degeneration of the epithelium and subcapsular alterations, with a normal nucleus.

Diagnosis.—Postoperative tetany cataracts are found most frequently in women; this is only because women are prone to thyroid disease. The cataracts are bilateral, and develop ordinarily within a period of two or three years after thyroidectomy. The incidence is much greater in persons who have had two or more operations on the thyroid.

In a young or middle-aged woman with rapidly developing bilateral cataracts, postoperative tetany should always be considered. The history is that of thyroidectomy followed by bilateral tingling sensations and tonic cramps in the hands and arms; there may also be a history of cramps in the feet and legs, general convulsions without loss of consciousness, choking spells and even a psychosis. In many cases the tetany becomes latent sooner or later, and there are no manifest symptoms. If this occurs soon after the operation, the patient may not associate the loss of vision with the goiter operation, and it is necessary for the surgeon to think of such a possibility. In a state of latent tetany, trophic changes may be present, e. g., falling hair, disturbances of the nails and skin pigmentation, but usually there are no symptoms, only certain signs and findings that may be elicited by the surgeon. Such, for example, are Erb's, Chvostek's and Trousseau's signs, all indicative of hyperexcitability of the neuromuscular structures. As to the actual lens, the slit-lamp alone will reveal the early changes; later changes may be seen with the ophthalmoscope or by gross inspection.

The lens opacities are bilateral, but the appearance of the cataract depends on the stage at which it is seen. Undoubtedly it is impossible to see the lens changes with the ophthalmoscope in the earliest stages. With the slit-lamp microscope one can see the cataract as it begins to form and follow it through its various stages. In case 3, for example, I was able to see the cataracts at the very beginning. In the literature there appears to be no typical picture of postoperative tetany cataract.

43. Edmunds, W.: Double Cataract Following Experimental Total Thyroidectomy in a Dog, Proc. Roy. Soc. Med. (Sect. Ophth.) **9**:53, 1915.

Landsberg [3] found that the lens changed into a gray-white mass up to the anterior cortical layers. Westphal [7] found the entire lens to be slightly opaque, with increased density at the anterior and posterior poles. Purtscher [11] and others saw patients with fully matured cataracts, in some of which swelling of the lens was described. Knüsel [21] concluded from his series of four cases that, with the slit-lamp, there were three kinds of opacity: (1) dustlike, (2) flaky and (3) crystals. He felt that the posterior cortical opacity was not unlike the ordinary complicated cataract. He described the location as being characteristic: The flaky and crystalline opacities were located in the cortex and the dustlike opacities reached into the embryonal nucleus, but the capsule, subcapsular line and central interval were always clear. One wonders if the dustlike opacities were not congenital. I have seen a diabetic cataract that had exactly the same appearance as one portrayed by Knüsel (fig. 2) as being typical of tetany cataract. Kast [24] found the first changes close under the anterior and posterior capsules and, more rarely, under the subcapsular line. Usually there were more opacities at the posterior pole of the lens. He found the particles coalescing and forming vacuoles; water slits could be seen. He stated that Vogt found the lens thinner in the anteroposterior axis in these cases and believed it characteristic. Kast felt that there was a characteristic morphology: fine symmetrical subcapsular opacities with anteroposterior thinning of the lens, associated with accentuation of the outline of the lens fibers. In one case reported by Jacques [25] there were diffuse granular opacities throughout the lens, but they were especially dense in the center. In the other case there were perinuclear opacities. Hunter's [26] patient was examined by Goulden who found superficial white flaky opacities near the anterior and posterior capsules; also there were red, blue and green crystals. A few fine powdery opacities were seen in the nucleus. Cole [28] reported his case as showing fairly generalized cataracts, with pyramidal masses of opacity. Heine [22] felt that there was no especial slit-lamp picture. His case showed three layers of diffuse opacity in the cortex; the appearance was similar to that of a zonular cataract. Sidler-Huguenin [20] found thick opacities in the anterior part of the lens. Greppin [4] found the early opacities arranged in a radial spokelike manner, and later there was a central dense milky opacity in the lenses.

It is apparently the opinion of most authors that the lens changes in tetany, diabetes, myotonia atrophica and ergotism are similar.

Each of my cases showed a different ophthalmoscopic and slit-lamp picture. In case 1 the right eye showed innumerable points of opacity, of irregular sizes, throughout the only visible portion of the lens, i. e., the anterior cortex. The cataract in the left eye of this patient was less mature and was composed of a thin layer of finely granular and

coarse irregular opacities in the anterior and posterior subcapsular areas, with a tendency to grouping into a spokelike figure. There were also some crystals in the affected areas. Surrounding the nucleus was a homogeneous opacity of the lamellar type. The changes were most prominent in the posterior subcapsular zone. In case 2 both lenses appeared by gross examination to be affected with ordinary senile cataract. When seen with the slit-lamp the opacities appeared thickest in the anterior subcapsular zone, with a less opaque area between that zone and the anterior surface of the nucleus. One could not see beyond the latter area. In case 3, which was the most interesting, because of the opportunity to study the early formation of tetany cataracts, the changes were present only in the anterior and posterior subcapsular zones. There were irregular aggregations of finely granular opacities, confined to a thin layer directly under the anterior and posterior capsules. The posterior opacities were more numerous in one eye, but in the other the anterior opacities were more pronounced.

From the varied appearances of the lenses in my three cases it would seem that tetany cataract has no pathognomonic morphology. In a patient with early subcapsular opacities one should make a thorough general examination with the thought in mind that the lens changes may be due to a metabolic disturbance.

Prognosis.—Nothing has been found to prevent the advancement of the cataract. It would seem that extraction of such a cataract is more prone to be followed by complications than in the case of senile cataract.

Treatment.—Jacques [25] believed that treatment of the tetany controlled the neuromuscular manifestations but not the cataracts. He saw lens changes progress in his patients in spite of control of the other manifestations of tetany. Cole [28] felt that parathyroid extract had no effect on the lens changes. In all of my cases manifest symptoms of tetany were absent during the development of the cataracts. One case was studied in the hospital for over a year, during which time the cataracts developed and continued to advance in spite of constant treatment which controlled the other manifestations of tetany.

Operation is the only known treatment for such cataracts. There is no indication that the operation in itself is in any way different from any other cataract extraction. However, in view of the delayed spontaneous intra-ocular hemorrhages encountered by Vogt in two cases and those occurring in the two patients operated on by me, it is recommended that such patients receive calcium and parathyroid hormone before, during and after the extraction.

SUMMARY

Rapidly developing bilateral cataracts in presenile persons, especially those of the female sex, may be due to postoperative tetany. In patients of this age one should always think of such a possibility. The diagnosis is made from (1) a history of thyroidectomy followed by spasms of the upper extremities and perhaps of other parts of the body, (2) a low blood serum calcium associated with a high blood phosphorus and (3) signs of hyperexcitability of the peripheral nervous system (Erb's, Chvostek's and Trousseau's signs).

The forty-two reported cases of postoperative tetany with cataracts have been discussed, and to these I have added three typical cases.

Cataracts develop with either manifest or latent tetany, and they advance despite treatment that may control all other manifestations.

Probably there is no pathognomonic picture of this type of cataracta complicata, but it seems that the first changes appear as aggregations of fine opaque granules directly under the anterior and posterior capsules of the lens.

The prognosis should be guarded because of the fact that delayed spontaneous hemorrhage may occur after lens extraction. Before and after extracting such cataracts the patient should receive parathyroid hormone, viosterol and a high calcium intake, in order that the blood and tissues may be in as nearly a normal state as possible.

SYMPATHETIC OPHTHALMIA FROM A NON-PERFORATING TRAUMA

REPORT OF A CASE *

HARVEY D. LAMB, M.D.
ST. LOUIS

History.—A girl, aged 6 years, was brought for consultation to Dr. William E. Shahan on Feb. 11, 1928, about one hour after being struck in the right eye by a stick. Only several small abrasions on the right cornea were noted; no deeper wound could be found. The lower part of the anterior chamber was occupied by blood. Hemorrhage completely filled the anterior chamber on the following day, and the intra-ocular tension, to the fingers, was elevated. On the first of April, there was perception of light in the right eye with apparently good projection. By April 21 (ten weeks after the injury), the uninjured fellow eye showed cloudiness of the aqueous and numerous posterior synechiae. On the same day the softened right eye was enucleated. In spite of the most intensive treatment with atropine-cocaine in oil, sodium salicylate, neoarsphenamine, diphtheria antitoxin and immunogen, the uveitis in the left eye persisted with remissions and exacerbations until February, 1929, when the eye began to soften and shrink.

The enucleated right eyeball was fixed in formaldehyde, embedded in celloidin and sectioned, hematoxylin and eosin stains being used. Although serial sections were not made, all parts of the eyeball were examined for a possible intra-ocular foreign body.

Macroscopic Examination.—The eyeball was a little shrunken, and the cornea and the sclera were everywhere a little thicker than normal. The base of the iris was applied for varying distances to the posterior surface of the cornea. The iris and ciliary body were greatly thickened by cellular infiltration; the choroid, however, showed but little macroscopic change. The pupil was widely dilated by the atropine used in the treatment; the optic papilla was moderately swollen.

Microscopic Examination.—In the posterior layers of the central part of the cornea, the corneal corpuscles contained fine grains of a yellowish-brown pigment which was probably derived from the blood. A thin, diffuse infiltration with small lymphocytes was also present between the lamellae of the substantia propria of the cornea. The anterior emissary blood vessels were increased in number and showed thin coatings of plasma cells and small lymphocytes. Around some of these emissary blood vessels were also found cells containing granules of hemosiderin blood pigment. A few polymorphonuclear neutrophilic leukocytes were seen in some of these blood vessels.

The iris was generally thickened due to a dense cellular infiltration posteriorly and to a serous fluid-infiltration anteriorly. The character of the cellular infiltrate varied considerably but was generally composed of plasma cells and small lymphocytes enclosing large islands of epithelioid cells. The contraction of cicatricial

* Submitted for publication, Aug. 10, 1931.

* From the Department of Ophthalmology, Oscar Johnson Institute, Washington University, St. Louis.

membranes on the anterior surface of the iris had caused the eversion of the pupillary margin of the iris where the latter was considerably thickened by inflammatory infiltration. The posterior pigment epithelium of the iris was disintegrated in many places over the everted pupillary portion of the iris, and loose pigment cells derived from it were found in the adjoining iris-stroma. Lying on the cicatricial membrane on the anterior surface of the iris were small amounts of wandering small lymphocytes and epithelial cells derived from the unpigmented and pigmented ciliary epithelia. A small amount of posterior synechia was present, binding the iris to the anterior capsule of the lens by a thin cicatricial membrane; at this place a thin pupillary membrane partially filling the pupil lay in apposition with the wrinkled lens capsule.

The vascular layer of the ciliary body, particularly anteriorly, was in general considerably thickened by a dense infiltration of small lymphocytes and plasma cells; toward the inner side of this cellular infiltration lay islands of epithelioid cells with a few giant cells. The pigmented and unpigmented epithelia over the flat portion of the ciliary body were in places proliferated, disintegrated or even entirely absent. One large area of the unpigmented epithelial layer over the flat part of the ciliary body was detached by hemorrhage and serous fluid. Along the inner side of the ciliary body, in the posterior chamber and in the anterior part of the vitreous were many wandering cells derived from the ciliary epithelial layers intermingled with small lymphocytes. In some of these cell groups were young fibroblasts evidently derived from the proliferated ciliary epithelial cells.

The choroid was atropic with considerable newly formed connective tissue, capillaries, young fibroblasts and a thin diffuse infiltration of small lymphocytes and plasma cells. The retinal pigment epithelium at its anterior end presented areas of proliferation, but in places it had completely disappeared as a distinct layer; posteriorly, this layer showed cystic degeneration with partial loss of pigment. The retina was invaded at several points in its anterior end by pigment cells proliferated from the retinal pigment epithelium. The retina generally presented fine cystic degeneration in the rod-cone and ganglion cell layers. The posterior part of the retina, together with the optic papilla, was moderately edematous.

Summary of Principal Anatomic Observations.—The principal anatomic observations were: sympathetic iritis and cyclitis; staining of the corneal corpuscles with blood pigment from the clinically observed hyphemia; cicatricial membrane on the anterior surface of the iris causing eversion of the pupillary margin of the iris; wandering small lymphocytes from the infiltration in the iris and ciliary body; wandering epithelial cells from the ciliary epithelia; posterior synechia and pupillary membrane causing by their contraction a wrinkling of the anterior capsule of the lens; moderate papilledema, and edema of the posterior part of the retina.

COMMENT

The differential diagnosis of sympathetic ophthalmia is made on the specific infiltration of the uveal tract in the exciting eye and the presence of a uveitis in the sympathizing eye; both factors were present in this case.

An intra-ocular foreign body, if present, would have been found because all parts of the eyeball were carefully examined when it was sectioned. The attending ophthalmologist, Dr. William E. Shahan, a physician of skill and experience, could scarcely have overlooked a

penetrating wound, for he carefully examined the eye within an hour after the accident.

Cases of spontaneous sympathetic disease have always been viewed with great suspicion. However, as yet nothing is understood about the essential factors inducing the development of this disturbance. Since true sympathetic ophthalmia can occur from a necrotic sarcoma of the choroid, the necessity of having a perforating wound or an opening in the eyeball preceding sympathetic disease is removed. Since one is forced to concede this much, the way is opened to explain sympathetic disease on a purely endogenous basis.

I was unable to find in the literature a case analogous to this one, for, in those reported as spontaneous sympathetic ophthalmia, either the histologic picture of the uveal infiltration in the exciting eye was not specific, or the involvement of the fellow eye was absent or very mild.

In Kitamura's [1] case, the history of the disturbance in the exciting eye was very indefinite, and the infiltration in the ciliary body was not typically specific of sympathetic disease, although it was more so in the choroid.

In Botteri's [2] and Meller's [3] cases, an iridectomy had been performed, and although uveitis had been present before the operation, it cannot be denied that the character of the infiltration in the uveal tract may have changed considerably as the result of something introduced into the eyeball at the operation.

The uveal infiltration in Weigelin's [4] case was definitely specific in the exciting eye, but before the enucleation of this eye, the uveitis in the fellow eye improved considerably under mercuric inunctions, so that its vision became almost normal again; repeated recurrences of inflammation in the fellow eye were similarly treated, with constant and rapid improvement.

In Guillery's [5] case, the fellow eye definitely showed no uveitis but only sympathetic irritation, which rapidly disappeared following enucleation of the exciting eye.

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1. Kitamura, S.: Beiträge zur Kenntnis der sympathischen und sympathisierenden Entzündung mit histologischen Untersuchungen sympathisierender Augen, Klin. Monatsbl. f. Augenh. **45**:211, 1907.

2. Botteri, H.: Idiopathische Iridochoroiditis unter dem Bilde einer sympathisierenden Entzündung, Arch. f. Ophth. **69**:172, 1908.

3. Meller, J.: Zur Frage einer spontanen sympathisierenden Entzündung, Ztschr. f. Augenh. **30**:379, 1913.

4. Weigelin, S.: Zur Frage der pathologisch-anatomischen Diagnosen-Stellung der sympathischen Ophthalmie, Arch. f. Ophth. **75**:448, 1910.

5. Guillery, H.: Ueber einen seltenen Befund bei sympathisierender Entzündung nebst Bemerkungen über die hinteren Abflusswege des Auges, Arch. f. Augenh. **91**:39, 1922.

The recent case of Delaney [6] is of great interest and importance. Clinically, it presented a completely typical case of sympathetic uveitis following a nonperforating trauma. The observations are most important, in that an exciting eye with the histologic picture of only a moderately intense chronic uveitis induced a sympathetic uveitis in the fellow eye. One is forced to conclude, therefore, that the well recognized typical histologic picture of sympathetic uveitis in the exciting eye is not indispensable to the initiation of a sympathizing process in the fellow eye.

SUMMARY

A child 6 years old suffered an abrasion of the cornea of the right eye from a blow with a stick. There was no penetrating wound. Ten weeks later the left eye showed involvement of the uveal tract, and the right eye was enucleated. In spite of intensive local and general treatment of various kinds, vision in the left eye was completely and hopelessly lost. Anatomic examination of the enucleated right eyeball revealed a definite sympathetic iritis and cyclitis. Fibrinoplastic exudate was small in amount; it formed some posterior synechial and pupillary membranes.

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6. Delaney, J. H.: Sympathetic Ophthalmia Unassociated with Perforation or Rupture of Eyeball, Arch. Ophth. **5**:781 (May) 1931.

UNUSUAL RETINAL VASCULAR CHANGES IN TRAUMATIC INJURY OF THE CHEST

ANGIOPATHIA RETINAE TRAUMATICA (PURTSCHER) *

WILLIAM H. STOKES, M.D.
OMAHA

Ocular disturbances that are the result of injury to other parts of the body are extremely rare. Angiopathia retinae traumatica is a name given by Purtscher [1] to a peculiar fundus change in which there is probably an extravasation of lymph into the retinal tissues, as the result of a severe injury, generally a head injury. In some instances of trauma from severe compression of the chest, vascular complications may arise. The changes that occur in the fundi are of importance not only to the ophthalmologist, but also to the internist and surgeon.

Changes in the fundus accompanying such injuries have been reported from several European clinics, and the writers have discussed the etiology and possible pathology, but there still exists considerable controversy concerning their cause. In reviewing the available literature on these interesting changes, I find little reference to them by American ophthalmologists. In fact, little has been written, and practically no experimental work has been done to account for the exact cause of these retinal changes.

REPORT OF CASE

Mr. F. L. R., aged 56, was in an automobile accident and was thrown from his car three weeks before admission to the hospital. He fell against a telephone pole, striking the left side of his chest. He retained consciousness. This accident was followed by immediate blindness in both eyes. When he was led to another car, he complained of pain in his left shoulder and chest. Dr. E. Sheldon Watson of Lusk, Wyoming, who referred the patient, gave this additional information: "At the time of the injury or following it, there was no discoloration of the face or eyelids, and there was no evidence of trauma about the head. There were, however, a few petechial subconjunctival hemorrhages in the region of the outer canthus of the left eye. There was no bleeding from the nose, gums, pharynx or ears, nor was there any leakage of cerebrospinal fluid. All reflexes were normal. The temperature was 98 F.; the pulse rate, 80; the blood pressure, 115 systolic and 80 diastolic. About the third day a slight transient glycosuria appeared, which disappeared the following day." After admission to the hospital (three weeks after

* Submitted for publication, Sept. 4, 1931.

* Read before the meeting of the Nebraska State Medical Association, May 12, 1931, at Omaha.

1. Purtscher, O.: Noch unbekannte Befunde nach Schädeltrauma, Ber. ü. d. Versamml. d. ophth. Gesellsch., Heidelberg, 1910; Angiopathia retinae traumatica: Lymphorragien des Augenhintergrundes, Arch. f. Ophth. **82**:347, 1912.

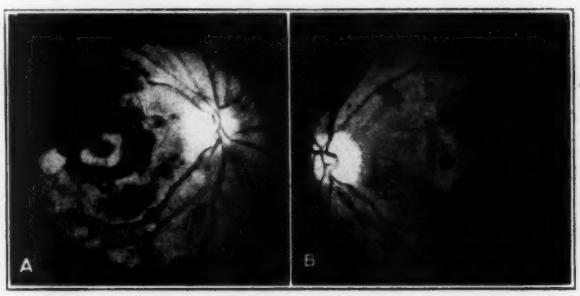
the accident), Dr. R. W. Bliss gave the following report: "The patient complains of soreness in his right chest. There is definite impairment of resonance with markedly decreased voice sounds at the right base, probably due to the fracture of the ribs and probable hemothorax. The heart tones are fair, and there are no murmurs; the blood pressure is systolic 95 and diastolic 70. The results of the neurologic examination are essentially negative. There is no disturbance of sensation. The muscular power is good. The reflexes, both superficial and deep, are negative. The spine is normal." Fluoroscopic and roentgenographic studies of the chest showed a fracture of the second and third ribs on the left, and the eighth, ninth, tenth and eleventh ribs on the right. There was partial hydropneumothorax on the right, with the right side of the diaphragm elevated. The Wassermann tests of the blood and spinal fluid were negative. The spinal fluid was clear; the cell count, 4 and the protein, 0.015. Urinalysis gave negative results. Blood analysis showed: hemoglobin, 95 per cent; red blood cells, 5,130,000; white blood cells, 8,650; differential count, normal. The chemistry of the blood was normal.

An ophthalmoscopic examination revealed the following: In the right eye the vitreous was hazy, and the disk was slightiy blurred. The arteries were contracted, and the veins were full and congested. Along the course of the superior and inferior temporal vessels, and particularly along the venous channels, there were many discrete, elevated, whitish patches with round borders, some of them confluent and forming larger areas, giving the appearance of cotton-wool exudate. Along the course of the superior temporal vein there was a massive hemorrhage extending into the periphery and encircling the entire macular area. The macula itself resembled an island in a lake of blood, and the most central portion of the fovea showed a round hemorrhage. There were flame-shaped hemorrhages along the course of the inferior temporal vein. The white patches and hemorrhages were located in the superficial portion of the retina, partly covering the retinal vessels. The vision in this eye was reduced to shadows. In the left eye the retinal veins were markedly congested, the arteries were very narrow, and along the course of the superior and inferior temporal veins the same white patches were noted as in the right eye. The retina showed considerable loss in transparency, and the hemorrhages were not as extensive in this eye as they were in the right. However, extending along the course of the inferior temporal vein there was a massive hemorrhage, covering the vein in the periphery and encircling the area below the macula. Along the course of the superior temporal vein there were many small flame-shaped hemorrhages, especially in the neighborhood of the macula, extending into the periphery of the fundus. A hemorrhage of considerable size was located directly in the center of the macula. This hemorrhage was round and had the appearance of being deeper in location. The vision in the left eye was reduced to shadows. The intra-ocular tension was normal in both eyes. An ophthalmoscopic examination two weeks later showed some absorption of the hemorrhages, but the condition of the fundus was essentially the same. The vision had not improved.

REVIEW OF THE LITERATURE

Retinal changes after head injuries were described by Purtscher in 1910. The fundus picture, according to this author, is very striking and characteristic and is due to the direct effect of a severe contusion injury to the head, resulting in a sudden increase of intracranial pressure. Along the retinal vessels and particularly along the veins,

discrete, gray and white patches were seen. The veins were dilated and congested, and the hemorrhages observed were apparently due to rupture of the retinal veins. Purtscher was of the opinion that the injury of the head was responsible for a compression to the spine in its longitudinal axis. As a result of this compression there was an increased intracranial pressure, forcing the spinal fluid through the subarachnoidal spaces into the nerve head, and along the retinal vessels, extravasating into the retinal tissue through the ruptured perivascular lymph spaces. In 1912, Purtscher reported five more cases in which the retinal changes occurred as the result of head injuries, and his conclusions were again that a sudden increase in the intracranial pressure was responsible for a rupture of the perivascular lymph sheaths and the appearance of the white patches. Since that date reports of a few more cases have been added to the literature.



Angiopathia retinae traumatica; *A*, right eye and *B*, left eye.

Vogt and Knüsel,[2] and later Vogt,[3] including three cases of their own, brought the total of reported cases up to ten, thirteen eyes being affected. These writers concluded that the white opacities were mainly located on the temporal side of the fundus above and below the disk and along the venous trunks. The optic nerve revealed no pathologic process. The opacities were round, mostly discrete, but at times more confluent. They were milky to silvery white in color and were located in the inner layers of the retina. The patches and hemorrhages observed by these two authors were the direct consequence of trauma, a head injury. In none of their own cases was there a compression injury to the spine. According to Vogt, the marked passive congestion of the retinal circulation was responsible for a rupture of the perivascular lymph sheaths of the veins, resulting in exudates and hemorrhages.

2. Vogt, A., and Knüsel, O.: Die Purtschersche Fernschädigung der Netzhaut durch Schädeltrauma, Klin. Monatsbl. f. Augenh. **67**:513, 1921.

3. Vogt, A.: Weitere Beobachtungen über Purtschersche Fernschädigung der Netzhaut, Schweiz. med. Wchnschr. **53**:945, 1923.

In 1927, Rübel [4] observed another case of head injury in which this fundus picture was studied. The close relationship between the exudates and hemorrhages in his own case was clearly shown. Rübel attached considerable importance to the fact that these smaller hemorrhages were often covered by exudates, and some of the hemorrhages were not discovered until after absorption of the white patches. He believed that a sudden increase in venous pressure could produce structural changes in the neighborhood of the hemorrhages, which ophthalmoscopically appeared as white exudate, the exudate being possibly an infiltration of blood serum. Chou,[5] in 1929, reported the last case, bringing the total of reported cases up to twelve, in which the retinal changes were due to a head injury.

Perthes,[6] in 1899, first called attention to two cases of accidents in which there was an extensive discoloration of the head and neck region after a severe compression injury to the chest. Braun [7] also reported a similar cutaneous change of the head and neck region after a compression injury to the abdomen. In his case there were an extensive subconjunctival hemorrhage and bleeding from the nose. The discoloration of the face and neck is described by various other authors (Wienecke,[8] Milner,[9]) as bluish, bluish gray and purple, depending largely on the injury and duration of the discoloration. The cause of this cutaneous change is a venous stasis brought about by an overdistention of the veins and capillaries.

Donders [10] was the first one to observe an expansion of the retinal veins after forced expiration. This congestion is visible in the larger venous trunks over the nerve head area. Along with the dilatation of the veins there is a narrowing of the arteries.

Neck,[11] in 1900, is given credit as the first to discover changes in the fundus after compression injury to the chest. In the case reported by

4. Rübel, E.: Ein Fall von Purtscherscher Fernschädigung der Netzhaut durch Schädeltrauma, Klin. Monatsbl. f. Augenh. **78**:176, 1927.

5. Chou, C. H.: Angiopathia Retinae Traumatica (O. Purtscher), Nat. M. J., China **15**:592 (Oct.) 1929.

6. Perthes: Ueber ausgedehnte Blut extravasate in folge Kompression des Thorax, Deutsche Ztschr. f. Chir. **50**:436, 1899.

7. Braun, H.: Ueber ausgedehnte Blutextravasate am Kopf, Halse, Nachen und linken Arm in folge von Kompression des Unterleibes, Deutsche Ztschr. f. Chir. **51**:599, 1899.

8. Wienecke: Ueber Stauungsblutungen nach Rumph Kompression, Deutsche Ztschr. f. Chir. **75**:37, 1904.

9. Milner: Die sogenannten Stauungsblutungen infolge Ueberdrucks im Rumph und dessen verschiedenen Ursachen, Deutsche Ztschr. f. Chir. **76**:85, 1905.

10. Donders: Ueber die sichtbaren Erscheinungen der Blutbewegungen im Auge, Arch. f. Ophth. **1**:75, 1855; Ueber die Stützung der Augen bei exspirationischen Blutandrang, ibid. **17**:80, 1871.

11. Neck: Ueber Stauungsblutungen nach Rumph Kompression, Deutsche Ztschr. f. Chir. **57**:166, 1900.

him small capillary hemorrhages were seen near the macula, and with them a vitreous hemorrhage. After two months there was a transformation of the macular hemorrhagic area into a whitish one, with a corresponding central scotoma, with vision reduced to 4/12.

Wagenmann,[12] in 1900, reported a small striate hemorrhage in the retina after a severe compression injury of the chest. A laborer, 19 years old, was caught between two cars. The face of the patient had a bluish discoloration as the result of small hemorrhages into the skin of the face and neck. There was also a subconjunctival hemorrhage and bleeding from the mucous membrane of the mouth.

In the two cases reported by Béal,[13] the fundus picture simulated a thrombosis of the central retinal vein; that is, retinal edema, thin arteries, dilated and tortuous veins and retinal hemorrhages. Burrell and Crandon [14] reported a case in which small retinal hemorrhages were demonstrable, and Wienecke cited a case in which two small hemorrhages were seen peripherally situated, leaving the central vision unimpaired.

Stoewer's [15] patient, a miner, 26 years old, showed marked reduction of vision (light perception in the right eye and 4/60 in the left eye) three days after a chest injury. The pupils were dilated. In the right eye the retinal arteries were narrowed, the veins markedly congested, with striate hemorrhages along the veins. The optic nerve head of the right eye was normal, but over the macula there was a diffuse grayish-white exudate. In the left eye the veins were congested, and there was a small hemorrhage in the macula. In the neighborhood of the disk and along the vessels there were numerous grayish-white round spots. There was a bluish discoloration of the lids. This author is the first one to compare his findings with the ones reported by Purtscher in 1910.

Scheer [16] reported the eighth case in which the cause could be attributed to a compression injury to the chest. A railroad man, 35 years old, was caught between the bumpers of two cars. After a short period of unconsciousness, he noticed a marked reduction in vision of his left eye (vision in right eye, 10/20; left eye, 5/30). There was a subconjunctival hemorrhage, but no discoloration of the face or neck.

12. Wagenmann: Multiple Blutungen der äusseren Haut und Bindehaut combiniert mit einer Netzhautblutung, nach schwerer Verletzung, Kompression des Körpers durch einen Fahrstuhl, Arch. f. Ophth. **51**:550, 1900.

13. Béal, R.: Hemorrhagie rétinienne, oedème rétinien et atrofie optique par compression du thorax et du cou, Ann. d'ocul. **142**:89, 1909.

14. Burrell, H. L., and Crandon, L. G. R.: Boston M. & S. J. **146**:13, 1902.

15. Stoewer, P.: Sehnervenatrophie, Netzhautblutungen und Oedem in folge von Thorax Kompression, Klin. Monatsbl. f. Augenh. **48**:559, 1910.

16. Scheer, M.: Netzhautblutungen infolge von Kompression des Thorax, Arch. f. Ophth. **59**:311, 1904.

He had a hemothorax, but without a fracture of the ribs. There were no neurologic signs. In the fundus there were two retinal hemorrhages above, and below the macula along the course of the superior and inferior macular vein. Stähli's [17] patient, a man, 39 years old, was thrown out of a wagon with a resulting fracture of the sixth and seventh ribs. There was no evidence of a head injury. The patient was unconscious only a short period, and was seen by the ophthalmologist four weeks after the accident. His vision at that time was markedly reduced, and he recognized people only at a distance of 3 meters. The external examination of the patient gave negative results. An ophthalmoscopic examination revealed the characteristic changes described by Purtscher.

Berrisford,[18] in his paper on the ophthalmologic findings in traumatic asphyxia, reported a further case. A man, 47 years old, while demonstrating a 2 ton tunneling machine, was pinned under it through an accident. Eight minutes elapsed before he was released, but he retained consciousness throughout. A little later he passed into a stuporous condition in which he remained for four hours. On admission to the hospital, the clinical appearance was as follows: The entire face, neck and upper part of the chest were slate-blue as well as the external surface of the upper limbs. Where the collar band and elastic sleeve holders exerted pressure on the skin surface, the integument appeared normal in color and in sharp contrast to the adjacent pigmented field. There was marked distention of the veins of the neck and face together with a puffiness that involved the eyelids. The eyes were proptosed, the bulbar conjunctivae protruding between the palpebral fissures as the result of subconjunctival hemorrhages. The pupils were widely dilated and unresponsive to light. There were submucous petechial markings on both sides of the nasal septum, the soft palate and the tympanic membranes of the ears. There was a hemorrhage that occupied the position of the frenulum epiglottis. A fracture of the second, third and fourth ribs of the left side of the thorax was demonstrable. An ophthalmoscopic examination made on the fourth day following the accident revealed that in either eye there was a dilatation and increased tortuosity of the retinal veins together with a slight blurring of the disk margins, particularly the nasal halves. The left fundus showed two discrete, bluish-gray, elevated patches, approximating the superior temporal quadrant of the disk. The right fundus contained similar spots scattered about in the retinal area between the optic nerve head and the macula but not involving the latter. Some distance from the disk, an elevated exudative area ensheathed the inferior temporal vein. Despite the most searching examination, no

17. Stähli, J.: Zur Kenntnis der Angiopathia retinae traumatica, Klin. Monatsbl. f. Augenh. **55**:300, 1915.

18. Berrisford: Ophthalmological Findings in Traumatic Asphyxia with Report of Case, Arch. Ophth. **50**:411, 1921.

retinal hemorrhages could be detected in this patient. An examination was again made nine months after the accident, and there remained not the slightest trace of the preexisting change in the fundus.

Schneider,[19] in 1924, reported the case of a railroad man, 47 years old, who, on the day previous to examination, suffered a chest injury by getting between the bumpers of two railroad cars. There were petechial hemorrhages of the lids, but no internal hemorrhages, nor were there any fractured ribs. The external appearance of this patient was normal. The vision, however, was reduced to 0.5 in the right eye and 0.6 in the left. Ophthalmoscopic examination revealed the typical lesions described by Purtscher as angiopathia retinae traumatica. Four weeks after the injury, the vision returned to normal. Mitchell,[20] in an article on eye changes resulting from traumatic asphyxia, wrote of a 25 year old taxi driver who was pinned under a car. The pressure on the chest rendered him unconscious, and when he awoke in the hospital his vision was restricted to perception of hand movements. There were numerous petechial hemorrhages on the head, neck and conjunctiva, and a few hemorrhages in the right fundus with many exudates in the retina of both eyes.

COMMENT

Outstanding is the fact that the retinal changes reported are not due to a primary injury to the eyeball. According to Purtscher and others, the changes are the direct result of a severe contusion injury of the skull. The identical fundus picture has been observed after compression injuries to the chest and ophthalmoscopically cannot be differentiated from the ones originally reported by Purtscher (cases by Wagenmann, Scheer, Stähli, Schneider, etc.) That such an increase of intracranial pressure does occur after severe compression injuries to the chest has been shown experimentally by Willers [21] in rabbits after trephining operations. The intracranial pressure was increased by thoracic and abdominal compression, and was seen by a bulging of the brain through the trephine opening.

Best [22] considered that there was no essential difference between Purtscher's disease and commotio retinae or Berlin's opacity. But the latter condition has nothing in common with the retinal findings under consideration.

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19. Schneider, R.: Purtschersche Fernschaedigung der Netzhaut nach Thorax Kompression, Klin. Monatsbl. f. Augenh. **72**:640, 1924.

20. Mitchell: Eye Changes Resulting from Traumatic Asphyxia, M. J. Australia **1**:536, 1924.

21. Willers: Ueber die Dilitation der Blutgefässe des Kopfes nach schwerer Verletzung des Unterleibes, Inaug. Diss., Greifswald, 1873; cited by Wagenmann: Arch. f. Ophth. **51**:55, 1900.

22. Best: Commotio retinae als Fernwirkung, Klin. Monatsbl. f. Augenh. **63**: 578, 1919. Die Entstehungsursache der Purtscherschen Fernschädigung der Netzhaut durch Schaedelverletzung, ibid. **68**:725, 1922.

The cases reported by Berrisford and by Mitchell, and described as cases of traumatic asphyxia, should be considered in the general group; the retinal changes are identical with those described by Purtscher.

An explanation for these ophthalmoscopic changes must, of course, be speculative. In all probability they are the expression of a clinical entity traceable to a common cause. In this condition there arises at the moment of injury an increased pressure in the veins of the skull. These valveless channels confined, as it were, in a rigid box of fixed volume do not permit of much expansion. Consequently, one can assume that considerable back pressure may be transmitted to the blood column from the cavernous sinus and the central retinal vein, which may have a direct communication with the cavernous sinus. This theory has already been stated by Berrisford.

Whether the diminution of vision is temporary, prolonged or permanent depends mainly on the degree and amount of back pressure. In the main, transient disturbances of vision may be due to an intraocular venous stasis of short duration, implicating the retina and perhaps the choroid. Ophthalmoscopic examination in such cases may give negative results (cases reported by Braun and Perthes). Hemorrhages into the optic nerve or vaginal spaces may produce temporary inhibition of function of the optic nerve, or in more severe cases, a permanent partial or total loss of vision through degeneration of the optic nerve fibers (cases reported by Kock,[23] Roenne,[24] Beatson,[25] Parker [26] and Berrisford [18]).

The discrete, whitish, elevated patches that are located in the retina are of interest. Their superficial position has been mentioned. Their location along the borders of the veins is striking. The arrangement of the perivascular lymph spaces around the veins and the characteristic appearance of these white spots along the course of the veins associated with hemorrhages would suggest an escape of fluid, both lymph and blood, through the ruptured walls into the retinal tissue. These patches along with the hemorrhages may be the result of a sudden venous back pressure, and suggest an ophthalmoscopic evidence of a sudden increase of intracranial venous pressure.

Papilledema is the result of a slow and gradual increase of intracranial pressure, the mechanism of which is different.

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23. Kock, cited by Purtscher: Verhandl. d. deutsch. Gesellsch. f. Chir. **1**:217, 1911.

24. Roenne, H.: Sehnerven Atropie nach Stauungsblutungen, Klin. Monatsbl. f. Augenh. **48**:50, 1910.

25. Beatson: Scot. M. & S. J. **22**:485 (June) 1908; cited by Roenne (footnote 24).

26. Parker, F. J.: Optic Atrophy from Traumatic Asphyxia: Report of a Case, Arch. Ophth. **40**:159, 1911.

AN OPERATIVE PROCEDURE FOR PYRAMIDAL CATARACT *

ELIAS SELINGER, M.D.
CHICAGO

The different types of congenital cataract that are extensive enough to interfere with vision present a variety of surgical problems that have to be dealt with as early as possible in order to prevent the development of amblyopia ex anopsia. Discission, the procedure of choice in young children in whom it is necessary to render the eye aphacic, is not always applicable, as, for example, in the following case.

REPORT OF A CASE

History.—L. O., a Mexican boy, aged 6, was brought to the eye clinic on May 14, 1931, by his father, who said that the patient had had poor vision in both eyes and opacities in both pupillary zones since birth. As far as could be determined, the patient had had no inflammation of the eyes, and there was no history of any previous diseases. The father stated that he himself, his paternal grandmother, his father's sister and his father's two cousins and their two daughters and one son all had had cataracts since birth. The patient's father, who had bilateral microphthalmia, had had operations on both eyes in Mexico at the age of 26. His other three children had no difficulty with their eyes.

Examination.—Examination revealed a well developed, light brown Mexican boy of normal mentality and in good physical condition. He was able to see Worth's 2.5 cm. spheres at 20 feet with either eye. The eyeballs appeared smaller than normal, and the corneas measured 8 mm. in diameter. The right cornea had a deep opacity the size of a pinhead just below the pupillary zone at 6 o'clock. The anterior chambers were slightly shallower than normal, and each lens had a dense white, lustrous, disklike anterior polar opacity measuring 4 mm. in diameter, from the center of which a pyramidal mass, measuring 3 mm. at the base and from 2 to 3 mm. in its anteroposterior diameter, protruded into the anterior chamber. No fundus reflexes could be obtained with the undilated pupils, while with the pupils dilated to 5.5 mm. by atropine, good peripheral reflexes were obtained, but no fundus details could be made out. Skiascopy was impossible, and vision could not be improved with lenses, either with undilated or with dilated pupils. A diagnosis of bilateral microphthalmia and bilateral congenital anterior polar cataracts and macula cornae of the right eye was made.

Operation.—Since dilatation of the pupils with atropine did not improve vision, optic iridectomy was not indicated in this case. A successful discission might result in absorption of the lens cortex, but the fibrotic pyramidal mass would remain unaffected. According to Collins and Mayou,[1] such a pyramid consists of a dense

* Submitted for publication, Sept. 3, 1931.

* From the Department of Ophthalmology, Rush Medical College, University of Chicago.

1. Collins and Mayou: Pathology and Bacteriology of the Eye, Philadelphia, P. Blakiston's Son & Company, 1925, p. 598.

laminated mass formed by the proliferation of the cells lining the capsule. Calcareous salts may be deposited in this mass in cases of long standing, and sometimes, according to Treacher Collins,[2] this tissue is entirely surrounded by a hyaline capsule, the internal layer having been secreted by a single layer of epithelial cells coming from the margin of the affected area and insinuating itself between the laminated mass and the lens cortex, while the external layer consists of the true lens capsule. If this conical mass is not removed at operation, it may drop behind the iris and become attached somewhere in the posterior chamber, it may fall into the chamber angle, or there may even be adhesions of the plug to the posterior corneal surface, causing keratitis due to this irritation. Under unfavorable conditions, the pyramidal mass may become adherent to the pupil and thus nullify the results of the operation, and it is even conceivable that it may block the chamber

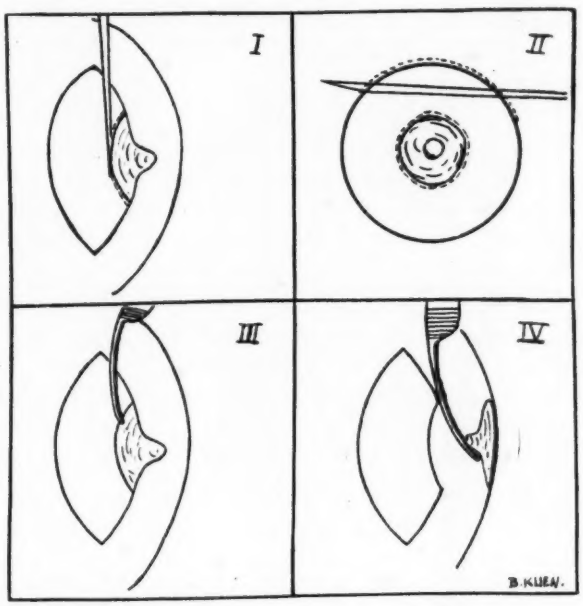

Diagram showing stages of the operation. *I* shows the undermining of the anterior polar opacity; *II*, the limbus incision with a Graefe knife; *III*, the base of the pyramid grasped with sharp-toothed forceps; *IV*, the sliding of the pyramid out along the posterior surface of the cornea after the pyramid was accidently rotated 180 degrees.

angle sufficiently to cause secondary glaucoma or, by irritation, iridocyclitis. Subsequent removal of the mass may be a dangerous procedure, because tearing away adhesions formed in the meantime may result in injury to the iris, iridodialysis, loss of vitreous, etc.

An effective method of dealing with this type of cataract is the procedure that I employed in this case.

Two drops of a 1 per cent solution of atropine were instilled into each conjunctival sac at three hour intervals on the day of the operation. With the patient under ether anesthesia, a Ziegler knife was introduced subconjunctivally from the

2. Collins, Treacher: Tr. Ophth. Soc. U. Kingdom **12**:89, 1892.

temporal quadrant just outside the limbus, and the point was carried into the anterior chamber and inserted just posterior to the opacity. The cataractous portion of the lens was completely undermined and freed from the underlying cortex. Technically, the separation of the opacity from the lens cortex is very simple, as the lens cortex is so soft that the knife cuts through it without resistance. This undermining is quite safe if the knife is introduced close to the limbus, as under such conditions no backward pressure is required to bring the point under the opacity. Another advantage in introducing the knife obliquely is that on removing it, the valvelike incision through the limbus prevents the escape of aqueous, which is very important in the next step of the operation, which consists of making an incision from 6 to 8 mm. in length along the upper limbus, similar to one made for ordinary linear cataract extraction. A cataract knife is preferable to a keratome for the limbus incision, since the point of the keratome might displace the freed opacity and make it more difficult to remove. A curved, sharp-toothed forceps is then introduced and the opaque tissue grasped and removed.

When an attempt was made to deliver the fibrotic mass by pushing a sharp Tyrrel hook through it and by grasping it with smooth forceps, the tissue was found to be so dense and resistant that the hook and forceps slipped off without getting sufficient purchase to pull the mass out of the eye. Gentle massage also failed to bring it out through the corneal opening. In the eye operated on first, attempts at grasping the conical mass resulted in rotating it 180 degrees, so that the pyramidal portion that had originally presented in the anterior chamber pointed posteriorward toward the vitreous. As the teeth of the forceps slipped off the thin tough edge of the base of the pyramid, removal was accomplished by introducing curved iris forceps posterior to the freed opacity in such a manner that the apex of the pyramid came to ride between the blades of the forceps. No attempt to grasp the apex of the pyramid was made, as this would only result in its slipping out. Instead, gentle pressure anteriorward was exerted, causing the base of the pyramid to press against the posterior corneal surface, and then at the same time by a light upward movement toward the corneal incision the fibrotic mass was easily delivered. In the second eye, the extraction was accomplished without difficulty with sharp-toothed forceps. Both eyes were operated on at the same sitting. Atropine was instilled into each conjunctival sac and a binocular bandage applied.

The postoperative course was uneventful. The intra-ocular tension remained normal, and there was a minimum amount of circumcorneal injection for the first ten days. In seven weeks, the entire cortex had been absorbed in both eyes; not even a secondary membrane remained, so that both pupils were black, except for a few strands of very fine capsular remnants along the pupillary margins. The fundi were easily seen by direct and indirect ophthalmoscopy.

COMMENT AND CONCLUSION

This combined method is applicable in extensive dense anterior capsular opacities when simple discission will not dispose of the unabsorbable fibrous-like opacity. It is preferable to linear extraction, as the preliminary dissection of the cataract does away with the danger of rupturing the zonular fibers if direct traction were to be attempted before the cataract is freed from the underlying lens. By introducing the Ziegler knife obliquely into the anterior chamber, the danger of dislocating the lens or injuring the posterior capsule, which might result in loss of vitreous on making the corneal incision with the Graefe knife.

is minimized. The postoperative course in the case reported shows that the making of a large opening in the capsule at the first sitting is not necessarily followed by a secondary glaucoma, despite the small size of the cornea, which theoretically should make the eye more susceptible to glaucoma as it indicates a reduced spacial relation in the chamber angle. Even if glaucoma had developed, it would have been a comparatively simple matter to spread the corneoscleral wound and to evacuate some of the opaque cortex. The large opening in the anterior capsule safeguards against the sealing over of the capsule, thus assuring constant contact of the aqueous with the cortex, and is also more likely to prevent the formation of a secondary membrane. A one-stage operation is preferable to an operation of two or more stages, as the likelihood of infection is lessened the less often an eye is opened.

SUMMARY

The dense laminated mass forming a pyramidal cataract, being unabsorbable because the epithelial cells from which it originates become condensed to a tissue of almost the consistency of hyalin, can be removed in a one-stage operation by the following procedure:

1. The opacity is dissected from the rest of the lens with a Ziegler knife. 2. A linear incision is then made along the upper limbus. 3. Then the pyramidal mass is grasped with sharp-toothed forceps and removed

Dr. Bertha Klien made the accompanying sketches.

55 East Washington Street.

Ophthalmologic Review

MODERN DEVELOPMENTS IN SPECTACLES *

JAMES E. LEBENSOHN, M.D.
CHICAGO

In recent years, so numerous have been the varieties of lenses produced by zealous manufacturers that a sporadic survey of the subject is necessary to evaluate properly the progress made. Cowan [1] and Jackson [2] have repeatedly inveighed against "copyright glasses" and insist that the physician should have a precise knowledge of the glass he prescribes.

IMPROVEMENTS IN LENS FORM

As long as very small lenses were in vogue, the flat lenses then used were fairly satisfactory. But in large flat lenses a noticeable marginal blur occurs, owing to the astigmatism of oblique eccentric rays. This has been almost entirely eliminated within a solid angle of 60 degrees by making the lens of proper shape. "If the lens contains a cylinder, only one principal meridian can be corrected—usually the horizontal. Moreover, a lens corrected for infinity is not quite correct for reading distance" (Cowan).

Cowan suggested that convex lenses up to 8 diopters have a constant inside curve of —6 diopters; above this, a constant front curve of +14 diopters. "The cylinder should be ground on the front surface except in the high powers, where it is easier and more accurate to grind on the back surface. The concave lenses should also have a constant inside curve of —6 diopters up to 6 diopters, after which the inside curves are increased to maintain a planoconcave form. When possible it is best to have the same back surface for a pair of lenses. In ordinary strengths the inside curve may vary between —4 and —5 diopters for reading glasses, and between —5 and —8 diopters for distance glasses, with a difference of less than 1 diopter between the back surface of the two lenses whenever possible."

A meniscus lens prescribed on this basis is practically as accurate as a specially designed precision lens. For instance, "in a +6 diopter

* From the Department of Ophthalmology, Northwestern University Medical School.

1. Cowan, A.: The Newer Forms of Ophthalmic Lenses, Arch. Ophth. **2**:322 (Sept.) 1929; Glasses, ibid. **5**:849 (June) 1931; Accessory Effects of the Correcting Glass by Its Position Before the Ametropic Eye, Am. J. Ophth. **13**:24, 1930.

2. Jackson, E.: Editorial, Am. J. Ophth. **14**:553, 1931.

lens, the residual astigmatism for a 60 degree solid angle is 0.15 diopter, while for a Punktal lens it is 0.03 diopter. For a solid angle of 40 degrees, which is more than enough, the residual astigmatism of the meniscus lens is negligible."

The coflexures dispensed by the manufacturing optician may or may not conform to these requirements. Positive spheres generally have a back surface of —1.25 ("flat lens"), —3, —6 or —9 diopters; negative spheres, a front surface of +1.25 ("flat lens"), +3, +6 or +9 diopters. Toric lenses are usually based on a +6 diopter curve, though a +9 diopter base may be used, and less often a +3 diopter base. The physician is in error who trusts that the optician will study the prescription and dispense the best coflexure. This task belongs to the oculist. A lens measure for checking the prescription should be part of his equipment. This simple and inexpensive instrument not only is of value in readily determining the "approximate power" of the lens investigated, but gives direct readings of the curves used.

The simple addition of the powers of the front and back surfaces does not give the exact power of a lens. The more recent trial sets and spectacle lenses are accordingly calculated and marked with reference to "effective power," which is the reciprocal of the back focal length and synonymous with "vertex refraction," a term coined by von Rohr in 1912. The "vertex" is the intersection of the optic axis and the center of the rear surface; hence the term refers only to refraction at the center. The increasing thickness at the center is of considerable importance in the higher positive powers. When the summation of the front and back curves is +10 diopters, the biconvex form is equivalent in effective power to 10.08 diopters, the convexoplane lens to 10.32 diopters, the —3 diopter meniscus to 10.55 diopters and the —6 diopter meniscus to 10.84 diopters. These lenses were 4.6 mm. thick at the center. In concave lenses, however, the thickness at the center may remain at a constant low figure, say 0.7 mm., for all powers, and a change in form would occasion practically no change in vertex refraction. The vertex refraction of any spectacle lens can be easily and accurately determined by an electrically illuminated instrument designed for the purpose.

Cowan pointed out that in myopia of high degree the correcting lens should be placed as close to the eye as possible. This enlarges the retinal image and, moreover, has the effect of a stronger lens placed farther away from the eye. To obtain the maximum result in extreme cases it might be of advantage to cut the patient's lashes.

TINTED GLASSES

"There is no need to protect healthy eyes from the ultra-violet radiation of ordinary daylight, for which the eye is self-adapted under

ordinary circumstances" (Lawson [3]). The ultraviolet of the sun is limited to rays longer than 3,000 angstrom units, and lower altitudes contain few of shorter wavelength than 3,500 angstrom units. The cornea absorbs all waves shorter than 2,900 angstrom units, and the lens those shorter than 3,500 angstrom units. Thus only the ultraviolet of from 3,500 to 4,000 angstrom units can normally reach the retina.

Glare denotes the unpleasant effect produced on the eyes by an excessive amount of reflection. Snow reflects about 70 per cent of the existing sunlight. The effects of glare would seem to be exerted in the luminous and infra-red direction rather than the ultraviolet. The conjunctivitis that accompanies snow-blindness is hence an effect of direct scorching.

For protection against infra-red radiation, peacock blue is by far the best tint to employ. This shade excludes all rays except those between 4,000 and 5,700 angstrom units, so that at one end all the ultraviolet is excluded, and at the other, all the yellow, orange and red.

The deeper shades of the yellow ferrous oxide glasses of Fieuzal (Euphos glasses) effect the most powerful protection of all known tints with regard to the violet end of the spectrum (Lawson [3] and Vogt [4]). Fieuzal 5 shuts off nearly all the blue and every ray shorter than 4,900 angstrom units.

"Absorption lenses" of the Crookes *A* type have the advantage of affording a general shade without materially altering color values. However, their constant use cannot be recommended, as the wearer becomes eventually so habituated as to be unable to do without them. Though often favored by patients with chronic conjunctivitis, it is seldom that any real relief is secured by their use. After the extraction of a cataract, however, a Crookes *A* lens is of value to compensate for the loss of the ultraviolet protection found in the lens and to counteract the condensing effect of the high plus correction. In the occasional case of photophobia with myopia, an absorption lens may likewise be advisable. These lenses transmit from 85 to 90 per cent of the visible rays, while ordinary white crown glass, when clear, transmits 91 per cent (Coblentz [5]). For protection against intense light, shade 2 (colored or smoked) or shade 3, transmitting, respectively, 37 and 14 per cent of visible light, should be chosen. For the mountains and the sea, Vogt recommended Zeiss Umbral glasses, which reduce equally the intensity of all parts of the spectrum.

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3. Lawson, A.: Tints and Their Value, Brit. J. Ophth. **9**:97, 1925.

4. Vogt, A.: Augenschädigungen durch die strahlende Energie, Klin. Monatsbl. f. Augenh. **85**:321, 1930.

5. Coblentz, W. W.: Glasses for Protecting the Eye from Glare, J. A. M. A. **95**:593 (Aug. 23) 1930.

For physical therapy work, the glasses, though perfectly opaque to ultraviolet radiation, must not be too opaque to the visible spectrum. Olive or brownish-green is the protective shade usually employed (Watters [6]).

BIFOCAL LENSES

"Many types of bifocal lenses have been made, but only the modern fused and one-piece forms, and, to a limited extent, the 'cemented wafer' have survived" (Sterling [7]). Some prescriptions, as, for example, strong cylinders with oblique axes, are not suitable for bifocals; and in prescriptions with widely different powers of distant lenses, the bifocals will introduce a vertical imbalance for reading, which the patient may not be able to overcome.

Optically, the one-piece bifocal ("Ultex," patented by Bentzon and Emerson in 1910) is similar to a cemented bifocal with the wafer ground to a knife edge, but in the one-piece bifocal both distance and reading fields are ground on the same piece of crown glass. Color aberration is practically unnoticeable in this type. However, by substituting dense barium crown glass for flint in the reading segment, a fused bifocal ("Nokrome," patented by Bausch and Lomb in 1926) has been produced with just as little chromatic aberration.

The "Kryptok," the first successful invisible segment bifocal, was invented by Borsch in 1899. It originally consisted of three elements cemented together. Ten years later, his son succeeded in welding the flint glass reading portion into the depression of the major lens by heating to such a temperature that the flint glass (which contained lead) melted slightly and fused into the countersink, whereas the crown glass major lens with its high melting point was not affected. He then finished the lens by grinding and polishing the outer segment side with a continuous surface exactly like that in a single vision lens.

In bifocals, the muscular errors set up by a variation in prism displacement must be guarded against. In reading, the visual axis is generally from 6 to 8 mm. below the optical center of the distance portion. If the prescription is for plus lenses, the optical center of the reading field will generally be within the reading area. In a minus bifocal, however, the optical center of the reading portion will be displaced above the segment, since the minus lens has the effect of a prism base down in the reading field. Percival [8] consequently does not recommend bifocals for myopes unless the myopia is of very low

6. Watters, B. D. H.: The Design of Ultra-Violet Goggles, Brit. J. Actinotherapy **4**:103, 1929.

7. Sterling, S.: Modern Bifocal Lenses, Bausch and Lomb Optical Company. Rochester, N. Y., 1930.

8. Percival, A. S.: Toric Spectacles, Brit. J. Ophth. **14**:623, 1930.

degree. Until recently a 38 mm. segment for the reading portion has generally been used, but in order to keep the optical center in the reading field for a variety of cases, smaller segments of 22 and 16 mm. diameter have been introduced. When the distance prescription is for a strong plus lens and the reading addition is low, the large segment bifocal is indicated; the small segment under reverse conditions.

The amount of inset of segments required depends on the interpupillary separation for distant vision, the working distance and the power of the distant lenses. For instance, for an interpupillary distance of 66 mm. with a working distance of 16 inches (40.64 cm.), when the distance correction is zero, the segments should be inset 1.9 mm.; for + 10 diopters, 2.5 mm., and for — 10 diopters, 1.6 mm. For every inch up to 12 (30.48 cm.) that the reading distance is nearer than 16 inches, add 0.1 mm. of inset, and for every inch up to 20 that the work is further than 16 inches, 0.1 mm. is to be deducted.

When the amount of prismatic displacement is too great for the patient to overcome; that is, when the vertical imbalance at the reading centers is 1 prism diopter or more, prism segment bifocals are the only double vision lenses that can be used successfully. Such bifocals have conspicuous dividing lines and cannot be made in the invisible fused and one-piece forms. Prism segments should be specified so that the prism is base up, and the entire vertical correction should be concentrated in one lens.

GOGGLES

"It is generally conceded that at least 90 per cent of all eye injuries due to external violence would be prevented by the use of properly fitted spectacles or goggles. . . . For every eye injured by a broken lens, thousands are protected from injury by their use. Patients with one blind eye should by all means wear spectacles, even if the functioning eye is normal" (Patton [9]).

In cases of special hazard, tempered or laminated glass is recommended. The latter type consists of two sheets of optical glass with a transparent binder between. When cracked, the irregular fragments are held together by the laminating substance. The finished lens of either type is slightly thicker than the ordinary optical lens, but is much superior in protective value. In the best aviation goggles, laminated "shatterproof" glass is used, the lenses are curved to conform to the contour of the face, and the rims are backed by rubber cushions, fur or chenille (Poppen [10]).

9. Patton, J. M.: The Protective Value of Certain Special Types of Spectacle Glass, J. A. M. A. **93**:1190 (Oct. 19) 1929.

10. Poppen, J. R.: Aviation Goggles, U. S. Nav. M. Bull. **26**:572, 1928.

TELESCOPIC SPECTACLES

Telescopic spectacles are low power, wide angled, binocular telescopes made as compact as possible. A positive objective is combined with a negative eye lens, separated by the difference of their focal length. By using fluor-crown glass of low dispersion in the objective and a glass of high dispersion in the eye lens, a tolerable degree of chromatic correction is secured with two simple lenses by (Levy [11]). With a specially designed rigid frame, the weight of the complete spectacles is about 30 Gm.

Telescopic spectacles often give visual improvement to patients with ocular disease, for whom ordinary glasses are of little, if any, value. Since the usable field varies inversely with the magnification, the magnifying power must be kept as low as possible, generally from 1.3 to 1.8 times. With this low magnification, it is possible to hold the head steady enough for comfortable observation. Nevertheless, because of the contracted fields and their unusual appearance, the patient cannot generally be made to use telescopic spectacles for distant vision. Moreover, as it is difficult to use the two eyes together at working distance, only one reading attachment is recommended which can be interchanged as needed from one eye to the other. "It is possible in many cases to use telescopic spectacles for near work, when the best distance vision with the ordinary correction is only 20/200" (Bruner [12]).

CONTACT GLASSES

Owing to the efforts of Heine, Zeiss has recently achieved an optically accurate ground contact glass. Some years previously, in cooperation with Fick,[13] Müller of Wiesbaden succeeded in blowing such glasses, but in blown glass work, perfect optical efficiency of the outer surface is almost unattainable.

Contact glasses are practically invisible. The ametrope, especially the myope, has restored to him a full visual field and a full range of movement. The retinal image of the myope is magnified 50 per cent in some cases. The greatest value, however, is in irregular astigmatism, especially in a conical cornea. In a case of conical cornea cited by Anderson,[14] the vision in the right eye was 20/200, and in the left eye, 10/200; with correction, vision in the right eye was 20/80 and in the

11. Levy, A. H.: Telescopic Spectacles, Brit. J. Ophth. **13**:593, 1929.

12. Bruner, A. B.: Telescopic Lenses as an Aid to Poor Vision, Am. J. Ophth. **13**:667, 1930.

13. Fick, A. E.: Eine Kontaktbrille, Arch. f. Augenh. **18**:279, 1888.

14. Anderson, J. R.: Contact Glasses in Conical Cornea, M. J. Australia **1**:216, 1930.

left eye, 20/120; but with contact glasses, vision in the right eye was 20/15—, and in the left eye 20/20.

"The modern ground contact glass is a thin hollow glass bowl which fits on the anterior portion of the eyeball beneath the lids in contact with the sclera, but is separated from the cornea by a fluid meniscus. It consists of a central optically effective crown which forms an arc of a sphere, surrounded by an optically inefficient peripheral brim, the former being the corneal, the latter the sclerotic portion. The diameter of the whole glass is about 20 mm., of which the corneal portion has a diameter of 12 mm. and is about 0.5 mm. thick at the vertex. Normal saline which is almost isotonic with the tears is used in the chamber" (Rugg-Gunn [15]).

In fitting contact glasses, two separate determinations have to be made; that of the most accurately fitting scleral brim, and the glass that gives the necessary refractive power. Comfort depends on scleral curvature, and every effort must be made to get this right. The wearer of contact glasses gradually acquires tolerance, and though at first he can use them but for an hour or two, he later may be able to wear them for eight hours or more. They must always be removed at night.

Ascher [16] suggested ring-colored contact glasses for albinos. The scleral portion should be of opaque porcelain white, and for cosmetic purposes it should have some vessels traced on it. In the corneal segment, a brown or blue iris ring surrounds a small transparent pupil. Such a glass would correct the ametropia, as well as affording light protection.

Though telescopic spectacles were designed in 1910 (by von Rohr at the inspiration of Hertel) and contact glasses have an even longer history, their use has been limited because of their costliness, the expensive trial sets required, the tedious examinations necessary, and not least by the difficulty of securing cooperation during the trying process of adaptation. Ophthalmology would be advanced and the semiblind greatly aided if some public-spirited person or agency could be persuaded to endow a special clinic for suitable cases in the various medical centers, provide the necessary material and produce trained ophthalmologists for this important field.

25 East Washington Street.

15. Rugg-Gunn, A.: Contact Glasses for Ametropia, Lancet **2**:1067, 1930.

16. Ascher, K. W.: Ringförmig gefärbte Kontaktgläser bei Albinismus, Klin. Monatsbl. f. Augenh. **85**:829, 1930.

Obituary

OTTO HAAB
1849-1931

Otto Haab died in Zurich on Oct. 17, 1931, in his eighty-second year. An assistant of that eminent ophthalmologist, Horner, a pupil of von Graefe, and of Eberth, the pathologist, his work from the onset gave evidence of an unusual ability to observe accurately, and to interpret, so that in the course of a very full professional career his many contribu-

OTTO HAAB
1849-1931

tions, as Streiff [1] says, make an important part of the history of ophthalmology during the past fifty years.

Haab contributed many papers on ocular pathology, and was one of the first to work on bacteriologic problems in ophthalmology. Ophthalmoscopy had, however, the greatest attraction for him, and our knowledge of macular changes, especially as they occur in the aged, and of hole in the macula, we owe to him. With unusual artistic ability, he was accustomed to make a rapid sketch of the eyeground, which led to the development of a sketch book, and later to the "Atlas of Ophthal-

1. Streiff, Jacob: Das Werk von Professor Otto Haab, Basel, 1931.

moscopy," which was the first of the well known Haab atlases. The other atlases were on external diseases and on operative surgery. These also appeared in an English translation, edited by George E. de Schweinitz. They enjoyed great popularity and were undoubtedly of the greatest value in the instruction of the young specialist.

Haab's most important contribution to ophthalmology was undoubtedly the development of the giant magnet with which, for the first time, minute particles of steel in the interior of the eye could be successfully extracted with the preservation of the eye.

In 1902, he was invited to attend the meeting of the American Medical Association, where he spoke on "Removal of Foreign Bodies from the Eye." The subject of injuries to the eye by foreign bodies, in the second edition of the Graefe-Saemisch *Handbuch der Gesamten Augenheilkunde,* was entrusted to him.

Though a skilled operator, he was also an excellent clinician, and many new conditions were first described by him. He wrote the chapter on "Ocular Lesions Dependent on Diseases of the Circulatory System" in Norris and Oliver's "System of Diseases of the Eye," 1900.

His public spirit was always ready to serve, and his popular addresses on subjects associated with ophthalmology are models of clearness, of style and interest, frequently imbued with a humorous turn.

The new eye clinic in Zurich, erected in 1890, is a monumental structure, well representing the modern ideas of hospital construction. Many pupils and assistants have passed through its doors, have added many important contributions to ophthalmologic literature and have carried the experience and results of Haab's careful training to all parts of the world.

A consideration of these achievements shows that Haab must have had an unusual working ability; at the same time, he had a decided artistic sensibility, and was of delightful, lively temperament.

A. K.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Aqueous Humor

A NEW METHOD FOR EXACT QUANTITATIVE DETERMINATION OF FLUORESCEIN. ARTHUR LINKSZ, Arch. f. Augenh. **104:** 470, 1931.

The author describes the previous methods for the quantitative determination of fluorescein and discusses its determination by nephelometric methods.

He finds that solutions of fluorescein of dilutions from 1:100,000 to 1:10,000,000 can be estimated with great accuracy with Kleinmann's nephelometer (*Biochem. Ztschr.* **178:** 301, 1926). A fair degree of accuracy is possible even in dilutions as high as 1:80,000,000. The measurement in the nephelometer is quicker and easier to carry out than methods previously used and will certainly be of value in experiments on the cerebrospinal fluid and aqueous.

F. H. ADLER.

Bacteriology and Serology

THE BACTERIOLOGICAL AND IMMUNOLOGICAL ASPECTS OF IRITIS: WITH SPECIAL REFERENCE TO ITS RELATIONSHIP TO BACTERIAL ALLERGY. J. A. KOLMER, Am. J. Ophth. **14:** 217 (March) 1931.

The author urges organized and systematic investigation of iritic and iridocyclitic eyes. He believes that all types of endogenous iritis are due to micro-organisms in the iris or to activities of bacterial toxins in the iris, or to acquired allergic sensitization of the ocular tissue to bacterial products produced in foci of infection elsewhere in the body. The possibility of exotoxins of streptococci produced in distant foci of infection being responsible for chronic recurring iritis is stressed. In the treatment for iritis the author urges vaccines of streptococcic and staphylococcic toxins (filtrates) instead of the usual heat-killed products.

W. S. REESE.

RETINAL TONOSCOPY IN HYPERTONUS. R. BIDAULT, Ann. d'ocul. **168:** 255 (April) 1931.

1. Relative arterial hypertension is often observed in general arterial hypertension, and its frequency is so much greater in patients suffering from a high degree of hypertension that it appears to the author to be related to the same causes as general hypertension itself.

2. Its value is variable, the high figure being met with particularly in hypertension of high degree; the importance of these variations has not up to the present been demonstrated.

3. It is almost constantly observed in patients with hypertension presenting ophthalmoscopic changes in the retinal vessels or true retinal complications of arterial hypertension (except macular chorioretinitis).

4. The frequent finding of this condition in simple hypertension, without general or ocular complications, does not appear to the author to have any prognostic importance.

S. H. McKee.

THE VALUE OF THE SEDIMENTATION RATE OF THE RED BLOOD CELLS IN OPHTHALMIAS. G. PAVKOVITS-BUGARSKY, Ann. d'ocul. **168:** 288 (April) 1931.

This article concludes as follows: The lymphatic ophthalmias, ulcers of trachomatous pannus, the tuberculous ophthalmias, syphilitic, rheumatic, nephritic, parenchymatous keratitis, iritis and iridocyclitis accelerate the sedimentation of the red blood cells. There are the purulent discharges, such as sties, dacryocystitis and serpiginous ulcer, which strongly accelerate the sedimentation. It seems that in the cases in which there is decomposition of tissue, even if it is a purulent decomposition, as in serpiginous ulcer, or nonpurulent, as in parenchymatous keratitis, the sedimentation is accelerated. For the purpose of differential diagnosis the reaction of the sedimentation can be employed in rheumatic iritis, but in other cases the diagnostic value is poor. The sedimentation rate is, however, of great prognostic value; especially in conditions in which relapses are frequent, such as iritis and parenchymatous keratitis, the reaction of the sedimentation always demonstrates whether the case is progressing favorably, or whether relapse may occur. Also, after operation, the reaction gives an indication of the progress of the case.

S. H. McKee.

Cornea and Sclera

RAPID INTERSTITIAL DEGENERATION OF THE CORNEA, FOLLOWING CHOROIDAL HEMORRHAGES. E. A. SEALE, Brit. J. Ophth. **15:** 514 (Sept.) 1931.

In the case reported, the condition was associated with diabetes and carbuncles. The patient was a woman, aged 51, who was taking insulin. The symptoms were those of acute glaucoma. Surrounding the cornea like a complete magnified arcus senilis and deeply situated was a ring of grayish-yellow color. The degeneration extended centrally, and the cornea became ectatic. Death occurred twenty-five days after the onset of the corneal condition. The eye was enucleated post mortem. The cornea was concave inward, and the central part was gone. The corneal layers were much separated by fluid and had hardly anything in the nature of a cell exudate among them. There was a blood detachment of the choroid, with a wide separation of the retina. No satisfactory section of the cornea was obtained.

To the author, the points of interest in the case were: the rapidity of the course, the painlessness in the presence of very high intra-ocular tension and the immunity of the corneal endothelium and epithelium. The latter gave a bright reflex throughout.

W. Zentmayer.

DYSTROPHIES OF THE CORNEAL PARENCHYMA. T. AXENFELD, Klin. Monatsbl. f. Augenh. **85:** 493 (Oct.) 1930.

Axenfeld includes under the term dystrophies the opacification of the parenchyma of the cornea occasioned by disturbances of its physiologic nutrition, but without any perceptible exogenous causes, i. e., injuries, inflammations or physicochemical lesions. Neither the so-called "trophic" changes due to disease of the trigeminus nerve nor the congenital, non-inflammatory changes are considered in this paper.

Congenital and hereditary changes may be of consequence in the production of acquired dystrophies, such as keratoconus, which reduces the elastic resistance of the center of the cornea. The metabolism of the cornea is not very well known, nor is its ability to change the material supplied by the marginal vascularization, by osmosis and by diffusion from the anterior chamber. Changes of the stroma may be endotheliogenous; i. e., "epithelial" dystrophies may be caused by an action emanating from the interior layers. Gerontoxon is caused by depositions of lipoids at a certain distance from the limbus because the tissues have lost their ability to change them, or because a larger quantity of lipoids is supplied by the marginal vessels than the cornea, under normal conditions, requires.

Axenfeld also refers to the influence of age on the development of gerontoxon, senile cataract and other changes in the eye. Hormonal therapy seems to be of no avail in senile cataract, although it may yield results in serious marginal degenerations of the cornea, such as chronic peripheral ectasia and peripheral groove formation. Adipose xanthomatous dystrophy belongs to this group. It is the result of cholesterol deposited in the form of anisotropal needle-shaped crystals. Groenouw's nodular dystrophy, the lattice-shaped form described by Haab and Dimmer and Fleischer's "hereditary type" are brought under the same caption as "nodular or latticed hereditary hyaline dystrophy of the cornea."

Calcareous dystrophy, or "calcinosis" of the cornea, is a slowly progressing primary calcification of the parenchyma, a rare form, first described by Axenfeld in 1917. Beginning near the limbus, it progresses toward the pupillary area, where minute dots can be seen with the slit-lamp. During eighteen years of observation, arteriosclerosis was never discovered. It is caused by diminished activity of the cornea.

Another form of dystrophy, bilateral symmetrical degeneration of the cornea with deposits of urea and sodium urate, was described by Uhthoff in 1915, and called uric dystrophy. In a patient, aged 53, a yellow opacity of the cornea, developing a short distance from the limbus, progressed toward the pupillary area. There were no signs of gout or uric diathesis. The elimination of urea was normal; none was found in the blood under a diet containing little purine. A similar corneal condition was never met with in gouty patients, proving that the dystrophy in this case was brought on by conditions in the cornea.

Myxedematous, or mucinous, dystrophy, observed by Axenfeld in a boy, aged 3, progressed for several years, forming white and prominent opacities in the center of both corneas. It developed into an opacity, in the shape of a butterfly, in one eye, while it finally covered almost the

entire cornea of the other. Later, vascularization produced absorption, promising further restitution. The cornea showed fibrification of the lamellae, and a positive mucinous fibrinoid reaction. The boy presented no symptoms of myxedema. Hormonal treatment, containing thyroidin, was of no avail.

Dystrophies of the cornea may present the same genesis, namely, a disease of the binding fluid (Kittsubstanz) between the lamellae, resulting in swelling and impregnation with various substances. The forms described are extraordinary, as they may develop at an age that is usually no longer subjected to processes of "imbibition" in the body or in the vascular system. Referring to Windau's idea of excessive exposure to sunrays producing calcinosis in a man, Axenfeld suggested protection of the eyes against the light. He mentioned the case of a boy, aged 8, who was afflicted with calcareous dystrophy, and who was given goggles of dark Hallauer glass. They were set in an especially tight-fitting hard-rubber frame, forming a permanently moist chamber, the eyes being, at the same time, protected against the ultraviolet rays. The calcareous deposits disappeared within a year to such an extent that the boy was again able to read. Saeger's galvanocautery from the limbus into the seat of the deposits may increase the resorptive process.

K. L. Stoll.

A Case of Successful Autotransplantation of the Cornea. V. P. Filatoff, Russk. j. opht. **8:** 305 (March) 1931.

The author reports a case of bilateral leukoma, in which the left eye had a total leukoma with faulty light projection, and the right cornea was transparent in the lower one-third, with light projection poor. He transplanted the transparent part of the right cornea into the upper nasal quadrant of the left cornea. A detailed description of the technic of the operation is given. The author stresses the fact that he used no forceps for the transplant, and that he used Graefe's knife and scissors instead of a trephine.

The transplanted cornea was smooth and transparent in the superficial layers in four weeks, but on the posterior surface could be seen connective tissue formation, which made the fundus invisible. The patient could count fingers at 3 feet. Since the patient had been under observation for one year and the thickness of the connective tissue had not increased, the author considered the present degree of transparency of the transplant permanent.

O. Sitchevska.

Experimental Pathology

Inoculation of the Human Conjunctiva with Bacterium Granulosis. F. I. Proctor, P. Richards, M. Greenfield, W. C. Finnoff and Phillips Thygeson, Am. J. Ophth. **14:** 318 (April) 1931.

Two human inoculations with Bacterium granulosis were made. The first subject, aged 52, had had a previous mild trachoma. The right eye was inoculated with five old strains of Bacterium granulosis obtained

from human cases of trachoma, while the left was treated with both excised monkey tissue and Bacterium granulosis obtained previously by culture from that animal. Conjunctivitis developed which was indistinguishable from beginning trachoma. Bacterium granulosis was not obtained from the secretion, but a monkey inoculated with the secretion developed the typical disease, and Bacterium granulosis was later recovered from this animal. The second subject, aged 44, had her left eye inoculated with a mixture of five strains of Bacterium granulosis. Acute conjunctivitis developed, followed by the appearance of follicles and induration of the conjunctiva, but the disease regressed without treatment.

W. S. REESE.

OCULAR METASTASIS OF AN UNSUSPECTED VISCERAL TUMOR. MORAX and VIALEIX, Ann. d'ocul. **168:** 161 (March) 1931.

To emphasize the point that all enucleated globes should be histologically examined, Morax and Vialeix report the following case: Mme. B., aged 61 years, had been seen in August, 1929, when a diagnosis of intra-ocular tumor on the right side was made. The left eye was normal. She was again seen in September, 1930, when the former diagnosis was confirmed. With the pupil dilated, a grayish-white tumor could be seen situated in the posterior part where it seemed to occupy about two thirds of this portion of the eye. A few weeks later, the enucleated eye was sent to Dr. Morax for examination. In the meantime the patient had died, fifteen days after the operation, from cerebral hemorrhage.

A histologic examination was made after fixation in Zenker's fluid and embedding in celloidin. For a number of reasons the slides were not examined for some months after the death of the patient, so that no further clinical information could be obtained. Microscopically, the tumor was not a sarcoma of the choroid, but examination revealed a peculiar tumor of epithelial type. It occupied the whole area from the papilla to the ciliary region on the nasal half of the globe, forming between the sclera and the detached retina a mass highly colored with hematoxylin, with villi-like processes. The tumor is described in further detail, and the following conclusions drawn: In the presence of ocular symptoms (detachment of the retina, ocular hypertension) that clearly indicate an intra-ocular growth, one must not always conclude that the tumor is a sarcoma of the choroid. Before admitting the nature of the tumor, one must assure himself by examination of the viscera that all other neoplasms of these organs can be excluded. On the other hand if in the absence of all extra-ocular symptoms, one has enucleated a globe, histologic examination of it must not be neglected, as this may suggest a hidden visceral epithelioma.

S. H. MCKEE.

General

THE OPHTHALMOSCOPIC EVIDENCES OF DEATH. N. PINES, Brit. J. Ophth. **15:** 512 (Sept.) 1931.

With the comment that it is not easy to be certain of death in a person immediately after the event, the author gives the usual advice and then proceeds to describe the changes in the ocular fundus. The

changes usually given are: the change of the usual yellowish red to a yellowish white, the emptiness of the vessels on the disk and near it in contrast with the peripheral vessels still filled with blood and pneumotosis (bubbles of air) in the retina.

From his personal observation, Pines finds that: the pupil dilates; the media are clear; by gentle pressure on the eyeball immediately after circulation has ceased, one can make the veins and then the arteries collapse on the retina near the disk; no venous or arterial pulse appears. The same applies to the disk. This the author considers an infallible and easily elicited sign of death.

In his experience, in persons not suffering from aortic regurgitation, within one or two minutes after death the disk becomes pale, but the retina remains rosy; the arteries are not changed, but the veins are somehow flatter. Arteriovenous compression is still preserved on the retina and the disk. Later the disk grows dead-white, and the retina more rosy; the arteries become thinner and the veins blackish, but not tortuous (in the living increased blackness is usually accompanied by an increase in tortuosity); the vessels on the disk are nearly empty, but still visible. After that (from fifteen to twenty minutes), the blood column in the arteries begins to break up, first of all on the retina near the disk and at the points of arteriovenous compression. The retina is paler but still rosy. Still later (from one to two hours), the retina is white, and the media became more hazy, but some of the large arteries are still visible on the retina as slightly dark red lines, interrrupted in places. The same applies to the veins, but they are less visible. Pines never saw early bubbles of air in the veins, contrary to statements in many textbooks.

W. ZENTMAYER.

REFLECTIONS ON SOME TERMS USED IN OPHTHALMOLOGY. H. FRENKEL, Arch. d'opht. **48:** 205 (March) 1931.

In this paper Frenkel calls attention to the inconsistencies and haphazard designations of some of the terms used in ophthalmology. He contrasts the terms interstitial keratitis and parenchymatous keratitis with pathologic lesions in the kidney, liver, etc., which have corresponding designations. He thinks that interstitial keratitis is the proper term. He also objects to the use of the term phlyctenular keratitis, as the condition is not a phlyctena. He suggests "focal leukocytic infiltration." This term should also be applied to "abscess of the cornea," as the condition is not a true abscess. Suppurative ulcers more nearly approach this condition and are really parenchymatous lesions. He objects to the terms descemetitis and keratitis posterior. Serous iritis he thinks would be more properly described by the use of the term cyclitis. Blepharoconjunctivitis and keratoconjunctivitis are also improper, especially if the definition of conjunctivitis is correctly considered. Keratoblepharitis he thinks is proper, as the cornea is subject to the same kind of disease as the skin of the lids. In place of ocular contusion and traumatic chorioretinitis, he suggests the terms "traumatic syndrome of the anterior segment," which would include a great many changes, and "traumatic syndrome of the posterior segment," which is not a true inflammation.

On the same grounds, he thinks that the terms myopic choroiditis and sclerochoroiditis should be replaced by such terms as posterior staphyloma, peripapillary atrophy, etc. He calls attention to Terson's discussion on this same topic in 1923.

S. B. MARLOW.

THE HYPOTONIES: ASTIGMATISM, ASTHENIA, ARTERIAL HYPOTENSION. C. FLANDIN and J. GALLOIS, Presse méd. **9:** 918 (June 20) 1931.

Patients are divided into two categories: those consulting the physician simply for poor visual acuity, and those having visual fatigue with headache.

When a low degree of ametropia exists in a person who has eye strain, with or without headaches, the refraction seemingly not enough to cause these symptoms, the authors believe that hypotension plays an important rôle. They wish to emphasize the recent work of Monbrun, with whom they agree. The objective signs in these cases consist of good visual acuity accompanied by deficient attention, headache after attempted sustained attention and photophobia of a special nature which comes with continued fixation. General fatigue is the outstanding general feature of the condition, together with lowered arterial tension. Associated ocular symptoms are small degrees of refraction which should be corrected with infinite care; an accommodation that may be said to be never in repose; hyperemia of the nerve head, and marginal blepharitis that is always present to a slight degree. The authors wish to give their impressions rather than any dogmatic conclusions. The hypotony of these persons deserves further study.

L. L. MAYER.

Glaucoma

RESULTS OBTAINED BY IRIS INCLUSION IN GLAUCOMA. L. WEEKERS and R. HUBIN, Arch. d'opht. **48:** 186 (March) 1931.

The authors first describe the technic they have employed in forty-three cases of glaucoma. It is a modification of Holth's original operation. A conjunctival flap is dissected above down to the limbus, as in Elliot's trephining operation. The sclera is incised at the limbus with a cataract knife, the edge of which is placed perpendicular to the limbus, and an incision 6 or 7 mm. long is made with one or two strokes of the knife, from the surface downward into the anterior chamber. If the iris does not bulge into the wound with the escape of aqueous, it is pulled into it with forceps, and a meridional cut is made with scissors. The conjunctiva is then sutured over the exposed iris. Weekers and Hubin are of the opinion that the hypotension that sometimes results from this operation is advantageous rather than harmful, because of the resulting increased blood supply with the accompanying improved nutrition. Some of the especially favorable features of this operation are: (*a*) the benign postoperative course, (*b*) the rapid reformation of the anterior chamber, (*c*) the rarity of posterior synechiae, (*d*) the greater certainty of the production of a cystoid scar and (*e*) the greater degree of reduced tension.

The authors point out that the operation is easy to perform and is well tolerated by the eye.

Fifteen cases of acute glaucoma, eighteen of chronic glaucoma and ten of secondary glaucoma are presented in tables that show the tension before operation and at varying periods after operation. The best results were obtained in the cases of primary glaucoma. In the cases of secondary glaucoma, although the tension was reduced in the majority, the amount of reduction was not so great as in the cases of primary glaucoma.

S. B. MARLOW.

Hygiene, Sociology, Education and History

OPHTHALMIC EDUCATION. C. S. O'BRIEN, Am. J. Ophth. **14:** 302 (April) 1931.

This very interesting paper does not lend itself to abstracting. It is a résumé of the undergraduate and graduate teaching methods at the University of Iowa. The author believes that undergraduates should be taught mainly the ocular complications of general diseases and a few of the pathologic conditions of the eye, while the graduate student should spend two or more years on the basic and clinical aspects of ophthalmology.

W. S. REESE.

THE ROYAL WESTMINSTER OPHTHALMIC HOSPITAL AND ITS STAFF IN THE PAST. A. CADDY, Brit. J. Ophth. **15:** 498 (Sept.) 1931.

After a brief historic account of the hospital, a short biographic sketch is given of its surgeons from its foundation to the present staff. As most of the members of the staff are noted in ophthalmology, the reading of this paper will prove of interest and value.

W. ZENTMAYER.

Lacrimal Apparatus

CYSTS AND FISTULAS OF THE LACRIMAL GLAND. A. CANGE and H. DUBOUCHER, Arch. d'opht. **48:** 161 (March) 1931.

In this paper the authors report a personal observation of fistula of the lacrimal gland which developed after canthoplasty. They deprecate the practice of canthoplasty, not only because it is unsurgical and unsightly, but also because it may lead to troublesome complications. The literature on these conditions is reviewed, beginning with the publication by Schmidt in 1805. This review indicates that a distinction must be made between (1) simple fistulas, (2) true lacrimal cysts and (3) fistulas resulting from the opening of lacrimal cysts. Furthermore, it is important to determine whether the fistulas are acquired or congenital; whether the acquired fistulas are established early, the lesion being glandular or canalicular, and finally whether they are due to the accidental or surgical opening of a cyst. These various possibilities are discussed at length, together with the probable pathologic mechanism of

causation. The treatment for these conditions is surgical. The superiority of the procedure advocated by Bowman is affirmed. It consists in dissecting the tract of the fistulas and reimplanting it in the conjunctival culdesac above. In the author's case, this was successfully accomplished with the aid of a fine wire stylet introduced into the tract of the fistula.

S. B. MARLOW.

TWO CASES OF CONGENITAL ANOMALIES OF THE LACRIMAL PASSAGES. J. CHARAMIS, Arch. d'opht. **48:** 216 (March) 1931.

Charamis reports two cases in which there were supernumerary puncta and canaliculi. In the first case, each lower lid contained a second punctum symmetrically situated 1.5 mm. outside the primary punctum. Probing demonstrated that these puncta represented bifurcation of the canaliculus. This case is readily explained on an embryologic basis.

The second case presented on both sides in symmetrical locations on the skin, 2.5 mm. from the internal canthus, round, fairly large, pyramidal elevations with openings into them, from which tears had been noted to escape. These ducts were shown by probing to be connected with the culdesac. Their explanation is much more difficult on an embryologic basis. They may be fistulas.

S. B. MARLOW.

LACRIMONASAL TREPHINING AND CATHETERISM. R. ARGAÑARAZ, Arch. de oftal., Buenos Aires **6:** 325 (June) 1931.

The numberless medical and surgical measures invoked for the cure of chronic dacryocystitis can be reduced to three principal surgical procedures: (1) progressive catheterism with the classic series of Bowman's probes; (2) extirpation of the lacrimal sac; (3) dacryocystorhinostomy, by the external route (Toti operation) or by the internal or endonasal method (West-Polyak operation).

Catheterism would be the ideal procedure, but unfortunately by its means only from 6 to 8 per cent of the patients are cured, and even these are frequently exposed to relapses, necessitating a repetition of the probing.

Ophthalmologists concur in that extirpation of the lacrimal sac is antiphysiologic, but in many cases it is necessary. Until recently all patients with chronic cases of dacryocystitis were treated in this manner. The relative merits of this operation and of dacryocystorhinostomy have given rise to long and numberless discussions, maintained today principally by Meller of Vienna and Dupuy-Dutemps of Paris, the former holding that extirpation of the lacrimal sac should always be preferred; the latter considering dacryocystorhinostomy the operation of election. Argañaraz considers extirpation of the lacrimal sac specially indicated in: (1) chronic dacryocytitis with a serpiginous corneal ulcer, and (2) as a preliminary measure to a cataract operation in the presence of chronic dacryocystitis. He describes his operative method, the original points of which consist in: a preliminary injection, the previous day, of a 1 per cent methylene blue (methylthionine chloride, U. S. P.) solu-

tion into the lacrimal sac; a V-shaped incision, the upper arm being 0.5 cm. in length along the orbitopalpebral fold, and the lower branch 1.5 cm. long parallel to the inferior orbital margin; separation of the wound margins by means of four provisionally applied threads; separation of the internal wound margin with section of the orbicularis tendon, and separation of the external wound margin under the tendon, thus avoiding the annoying bleeding caused by cutting of the nasal artery.

Most of the failures of external dacryocystorhinostomy, or the Toti operation, are due to an improper selection of cases. The author considers the following as the fundamental indications of dacryocystorhinostomy by both the external and the internal method: (1) chronic dacryocystitis with mucocele, in which previous attacks of acute pericystitis have not occurred; (2) the nonexistence of obstruction in the lacrimal canaliculi; the author does not consider a prior slitting of the canaliculi as a contraindication; (3) freedom of the nose from any acute or chronic inflammatory lesion. The author performs the Toti operation along classic lines, with the same incision and separation of wound margins as in extirpation of the lacrimal sac; he establishes the bony communication with a drill or trephine, enlarging the preliminary opening with a cutting forceps; when possible, he fashions an H-shaped nasal mucous membrane flap according to the method of Dupuy-Dutemps, which he sutures to a similarly shaped lacrimal sac flap, but he often excises the nasal mucous membrane along the whole length of the osseous breach with a corresponding excision of the lacrimal sac wall, applying no sutures; finally, he closes the wound.

Argañaraz considers the West-Polyak operation relatively more difficult, as it requires a preliminary submucous resection of the septum in most cases.

The author finally decribes his lacrimonasal trephining, which consists, after a preliminary excision of the caruncle and a slitting of both canaliculi, in a perforation of the internal wall of the sac and underlying bone with a trocar that carries a perforated gold drain, which is left permanently in situ on withdrawal of the trocar, being sustained by a small hook at its upper end. This conversion of the closed lacrimal sac into an open and easily drained wound rapidly does away with the suppuration and annoying epiphora.

C. E. FINLAY.

Lids

TWO CASES OF TUMORS OF THE LIDS CAUSED BY FOREIGN BODIES AFTER OPERATION FOR ACUTE MASTOIDITIS. H. MITA, Klin. Monatsbl. f. Augenh. **86**: 59 (Jan.) 1931.

Two school children, a boy, aged 8, and a girl, aged 7, had granugenol oil, a German proprietary form of a liquid petrolatum preparation, applied to their wounds after operations for acute mastoiditis of the left ears. In the case of the boy the left side of the face was swollen soon after the operation, leaving solid, hard tumors in the lids, lodged chiefly in the epidermis, and somewhat in the tarsus and in the orbital wall. These tumors persisted for over a year. The same phenomena were noticed in the girl about a week after the operation. The orbits, globes and their motion were not involved in either case, nor were the

preauricular glands palpable. An attempt completely to shell out the tumors failed. The palpebral fissures remained narrowed. Histologic examination showed proliferating endothelial cells, partly in the process of necrosing, or of transformation into connective tissue. Polynuclear giant cells of various size were scattered all over. A portion of the connective tissue presented fibromatous structure; numerous round alveolae resembling fat cells were in evidence. The foreign matter producing the tumors was an oily substance which, in the author's opinion, may have been carried from the field of operation to their present location by way of the perivascular lymph spaces. The histologic picture reminded Mita of the granulomas observed in the neighborhood of the root of the nose after injections of paraffin for cosmetic purposes. Granugenol does not contain pure paraffin. No similar adverse results have been published.

K. L. STOLL.

Methods of Examination

TUTOCAIN FOR TONOMETRY. L. GENNARO, Arch. di ottal. **38:** 302, 1931.

The author compared 1 per cent phenacaine (holocaine) with 5 per cent tutocain by tests with von Frey's hairs in ten persons with normal sensitivity. The average of results showed that with 2 drops of 1 per cent phenacaine, sensation, as tested with a hair 0.06 mm. in diameter, was absent after one-half minute, began to return in six minutes and was normal in ten minutes. With 2 drops of 1 per cent tutocain, sensation was absent in one-half minute, began to return in four minutes and was normal in five minutes. With 3 drops of 5 per cent tutocain, sensation began after five minutes and was normal in ten minutes. In testing each patient, twelve areas of the cornea were touched four times each, and the number of contacts felt was recorded. The effect of 3 drops of 5 per cent tutocain was practically equal to that caused by the 1 per cent phenacaine. The irritation caused by the drops was much less with tutocain than with phenacaine. Hyperemia and damage to the epithelium were also less with tutocain. Neither drug affected the size of the pupil. After one and one-half minutes anesthesia was always sufficient for tonometry with either drug. The author concludes that tutocain is preferable to phenacaine for tonometry and should be tried in operations for glaucoma.

S. R. GIFFORD.

PANORAMIC SURVEY PERIMETER (UEBERSICHTSPERIMETER). F. SALZER, Klin. Monatsbl. f. Augenh. (Beilagehft.) **85:** 34, 1930.

The author gave a preliminary report on his panoramic survey perimeter (Uebersichtsperimeter) in 1927. He demonstrated the perfected model at the International Ophthalmologic Congress at Amsterdam in 1929. He has employed it, while making comparisons with other perimeters, during the last six years. The apparatus can be used with speed, and the method itself prevents the overlooking of defects. Negative scotomas can be detected. Bjerrum's campimetry may be added while the patient retains his position. The apparatus may be used, furthermore, for testing the light sense of the entire retina, or of its portions, and for physiologic optical experiments. Better results are frequently

obtained, in awkward patients, by means of this method than by other methods. Salzer's method meets most of the suggestions made by the commission on perimetry appointed at Amsterdam. K. L. STOLL.

A SIMPLE REGISTERING PHOTOCAMPIMETER. J. L. LACARRÈRE, Klin. Monatsbl. f. Augenh. **86:** 233 (Feb.) 1931.

A registering photocampimeter has been devised by the author which can be used with greater speed and simplicity than Bjerrum's screen, and with equal accuracy, for the central 30 degrees of the field of vision. The fatigue, Troxler's physiologic phenomenon, can be materially reduced by employing this small apparatus. It is used in a dark room and permits the examination of a considerable number of patients within a short time. The field may be taken at any desired distance under regulation of the intensity of the light by means of a rheostat. Luminous indicators for white and for colors facilitate the work; a special screen is not required. K. L. STOLL.

Neurology

PSEUDO-ARGYLL ROBERTSON PUPILS WITH ABSENT TENDON REFLEXES. W. J. ADIE, Brit. M. J. **1:** 921 (May 30) 1931.

Adie calls attention to a benign symptomless disorder characterized by pupils that react in accommodation but not to light and by absent tendon reflexes. Five of the six cases he describes came under his notice in the course of a few weeks. Though harmless in itself, it merits recognition because it is often mistaken for a manifestation of syphilis of the nervous system, with unfortunate consequences for the patients and their families. It is not surprising that all of these patients with "Argyll Robertson pupils" and absent tendon reflexes were thought to be suffering from syphilis of the nervous system, congenital or acquired. The correct diagnosis can be made with certainty by closely observing the contraction of the pupil during the act of accommodation for near objects. The true Argyll Robertson pupil reacts promptly and fully, often excessively, on convergence, and dilates again as soon as the effort to converge the visual axes is relaxed. In these cases the pupils show the so-called myotonic reaction; they do not respond to light; they contract slowly through a wide range during a sustained effort to converge; often they remain small long after the effort ends and, when they dilate again, do so slowly. J. A. M. A.

OPTIC NEUROMYELITIS. G. SALVATI, Arch. di ottal. **38:** 310, 1931.

A new case of this somewhat rare condition is described. A girl aged 14 was attacked by fever, pain in the joints and transient paralysis of the lower extremities and of the bladder, which subsided after two weeks. Five days after this, vision of the left eye was practically abolished; three days later the same condition occurred in the right eye. The globes were tender on pressure, but not painful. A week later

vision began to return in the left eye and five days afterward in the right eye. When the patient was seen by the author about two weeks later, vision was limited to counting fingers, with central scotomas inside of 20 degrees. The nerves showed postneuritic atrophy.

In comparing this case with about fifty similar ones in the literature, the only unusual observation is the occurrence of the symptoms of involvement of the cord preceding the visual disturbance, which usually occurs first. The course of neuritis is usually rapid, as in this case, proceeding to complete blindness of each eye in succession within one or two days after the first visual disturbance. Both eyes are usually involved, but a few unilateral cases have been reported. Vision has cleared up in many instances, often returning to normal. About 50 per cent of cases have terminated fatally. Postmortem observations in fifteen cases have shown an interstitial inflammation of the optic nerves and cord with degeneration of nerve fibers. The inflammatory processes in nerves and cord are separate, no inflammatory changes usually having been found in the brain itself. The cause is unknown, but apparently a common agent affects both nerves and cord. Treatment has apparently been without effect.

S. R. GIFFORD.

Operations

PRELIMINARY REPORT ON A NEW METHOD OF CORNEAL TRANSPLANT. RAMON CASTROVIEJO, Proc. Staff Meet. Mayo Clin. **6**: 417 (July 15) 1931.

Operations were performed on thirty rabbits, the methods of Elschnig and Thomas being used. Not one transparent flap was obtained, chiefly owing to lack of nutrition, lack of base of implantation and retarded healing. The transplant fell out and became infected or opacified. The author has used sharp razor blade knives. By beveling the transplant on two margins enough base of implantation for the transplant is obtained, the flaps are always of the same size, have very clear edges and are not traumatized; enough nutrition is furnished by conjunctival flaps, which also protect the transplant against infections, that give a certain amount of compression to keep the transplant in place during the first few days and that accelerate the process of healing.

Adherent transplants are obtained in nearly every case; infection is practically the only influence opposed to good healing. Good homotransplants have been obtained in about 50 per cent of rabbits.

W. ZENTMAYER.

THE RESULTS OF OPHTHALMIC OPERATIONS. T. H. BUTLER, Brit. J. Ophth. **15**: 481 (Sept.) 1931.

This article is a survey of the results of the most important operations on the eye obtained by the author during the past twenty-seven years in England and in Palestine.

The results of extraction of cataract are influenced by four factors: the skill of the surgeon, the character of the nursing, the behavior and condition of the patient and the nature of the environment. Butler considers the first not all-important; the second is of vital importance; the

third is probably the most important factor in success and, regarding the fourth, there is virtue in the "ophthalmic atmosphere"; eye wards are preferable to nursing homes.

The author summarizes: A patient in reasonable health who is operated on by a surgeon of sufficient ability and who is well nursed under good conditions has at least a 90 per cent chance of obtaining good acuity after an operation for the extraction of cataract.

In the treatment for congenital dislocated lens, he performs an iridectomy, using an iris hook, as it is impossible to seize the iris with forceps. The coloboma is laid opposite to the visible edge of the lens. If there is a perfect suspensory ligament, treatment had better end here. If the zonule is absent or very imperfect, a corneal incision is made across the axis of the coloboma and the lens is removed with a vectis.

In traumatic dislocation, if the lens has fallen into the vitreous and remains there, it is best left alone.

If the lens from time to time enters the anterior chamber, it should be removed. If it is at the time in the vitreous, and opaque, a preliminary iridectomy should be made. A large corneal section is made, and a strong beam of light is directed on the lens. It is drawn forward with a lens hook; a flat spoon is slipped behind it, and it is expressed. If the lens is in the anterior chamber, with the patient seated for the operation, often a downward section is best.

If acute glaucoma is seen early, treatment with physostigmine (eserine) often results in recovery. Iridectomy is the operation of choice. In glaucoma simplex, the author has in the past five years more and more given up trephining for the operation for iridencleisis or iridotasis.

In strabismus, he usually attacks both the external and the internal recti. Tenotomy is rightly considered a thoroughly bad unsurgical procedure. Recession is far better both in theory and in practice.

With an experience of four or five hundred excisions of the lacrimal sac, the author is well satisfied with the results. In the removal of magnetizable foreign bodies, he prefers the Haab technic, but sometimes finds it necessary to extract through a scleral incision.

W. ZENTMAYER.

Orbit, Eyeball and Accessory Sinuses

A CASE OF MONOCULAR PULSATING EXOPHTHALMOS. T. BARDANZELLU and N. VALLEBONA, Arch. di ottal. 38: 342, 1931.

A girl, aged 16, struck the region of the left upper lid on an iron bar. Besides some bleeding from the wound, swelling of both lids occurred, accompanied by severe headache. A few days later the left eye became proptosed, and diplopia was noted. The conjunctival vessels were much dilated, and pressure on the globe elicited an impulse synchronous with the pulse. A souffle was heard with the stethoscope over the globe and the left side of the cranium, which disappeared when the common carotid was compressed. The fundus showed marked hyperemia of the disk and cyanosis of the retinal vessels.

After ligation of the common carotid the exophthalmos was reduced from 26 to 23 mm., diplopia disappeared and the field increased in size. Vision remained 8/10. The condition remained the same after two months.

Interesting graphs made by Frank's method showed the pulsation of the globe and humeral artery with complete disappearance of the former after ligation. From a review of the literature it is seen that cerebral complications of ligation are observed almost exclusively in elderly patients with probable vascular changes, while the procedure has been well tolerated by children and young adults.

S. R. GIFFORD.

Physiology

THE EFFECTS OF TISSUE EXTRACTS ON INTRA-OCULAR PRESSURE. A. PASSOW, Arch. f. Augenh. **104:** 490, 1931.

In a series of cats under methenamine narcosis the blood pressure was measured by a mercury manometer in a carotid artery and the intra-ocular pressure by means of Wesseley's manometer. Extracts were made from pigs' eyes from the following tissues: (1) the whole posterior segment, i. e., the retina, uvea and sclera; (2) the vitreous, and (3) the lens. Extracts were also made from other organs of pigs, such as the intestine, lung, kidney, etc.

The author obtained the following results:

1. The extract from the uveal tissue alone reduced the blood pressure more markedly than the extract from the retina but was ineffective on the intra-ocular pressure. The extract from the retina, however, caused marked reduction in intra-ocular pressure and constriction of the pupil.

2. An extract of brain or spinal cord tissue had about the same effect on the intra-ocular pressure as did the retinal tissue.

3. Extracts from the thyroid, ovary, testicle and spleen had a somewhat weaker effect on the intra-ocular pressure than those from the retina, brain and spinal cord.

4. Other organs, such as the mesentery, intestine, lung and kidney, extracts of the tissue of which cause a marked fall in blood pressure, had little or no effect on the intra-ocular blood pressure and the pupil.

5. It made little difference whether the organs were taken from pigs or cattle, and rabbits reacted to the tissue extracts similarly to cats.

6. The effects of the extracts of the retina and brain could be inhibited by the previous administration of atropine.

7. The extracts of the retina and brain were ineffective after they had been heated or dialyzed.

8. The active factor is not a foreign protein, since the retina or the brain of the same animal was equally effective.

9. The active principle is not a simple nitrogenous substance, such as choline, histamine or a similar chemical, nor is it a lipoid that, like lecithin, splits off choline or similar active substances in the circulation.

10. The active principle is apparently identical with a protein of high molecular complexity.

11. These experiments lead the way to a further consideration of the treatment for glaucoma with organic preparations from the brain, spinal cord or retina.

F. H. ADLER.

THE EXISTENCE OF DEPRESSOR SUBSTANCES IN THE EYE. K. VELHAGEN, JR., Arch. f. Augenh. **104:** 546, 1931.

Alcohol and acetone extracts were made of the uveal tracts and the retinas of ox eyes immediately after slaughter. These extracts were injected intravenously into cats anesthetized with methenamine, or methenamine plus ether, and blood pressure readings were taken by a mercury manometer in a carotid artery. A comparison of the changes produced by these extracts was made with the changes following injection of histamine. A substance that lowered blood pressure was found in both the uvea and the retina. The effect of this substance, however, could be prevented by a previous atropinization of the animal, which led the author to conclude that the substance belonged to the choline group, which acts primarily on parasympathetic nerve endings.

A second substance was found, however, which was not influenced by previous atropinization and which therefore corresponded in action to histamine. It differed from the latter, however, in producing a rise in blood pressure in a rabbit under deep ether narcosis and in increasing the tone of the uterine muscle of the rat. This substance is probably similar to that described by other authors in extracts of the brain and liver.

The results of these experiments show that although histamine may be present in the eye, it is probably in very minute amounts. A discussion follows of the probable rôle played by these substances in pathologic processes, especially in exudative processes in the uveal tract and retina and in the origin of the miosis that accompanies uveitis.

F. H. ADLER.

CLINICAL RESEARCH ON THE RELATIONS BETWEEN OSMOSIS, BLOOD PRESSURE AND INTRA-OCULAR TENSION. E. WIECHMANN, Klin. Monatsbl. f. Augenh. **85:** 815 (Dec.) 1930.

The author discusses a publication on the same topic by F. Poos (Clinical Research on the Relations Between Osmosis, Blood Pressure and Intra-Ocular Pressure, *Klin. Monatsbl. f. Augenh.* **84:** 340 [March] 1930; abstr., ARCH. OPHTH. **4:** 738 [Nov.] 1930). In Weichmann's experience, the intra-ocular tension is not normal but lowered in typical hypoglycemia. He found an increase of hemoglobin and of concentration of the blood in hypoglycemic attacks, following high, toxic doses of insulin. Intense perspiration may almost completely stop urination and cause a loss of bodily weight. The same phenomena, however, may be found in healthy persons. In cases lacking perspiration, only irrelevant undulations of the intra-ocular tension have been observed. Wiechmann considers perspiration a characteristic symptom of hypoglycemia. In glaucomatous diabetic patients, he suggests experiments with therapeutic doses of insulin, with the administration of diuretics and a diet containing but little sodium chloride.

Regular examinations of the blood pressure and intra-ocular tension of fifteen persons, some of them diabetic, showed no correlation between the intra-ocular tension and the blood pressure in the hypoglycemic state. An increase of blood pressure was accompanied by a decrease of the

intra-ocular tension in some cases. These results corroborate the findings of Bruns, who showed that intra-ocular tension remains unchanged during a decrease or an increase of the blood pressure.

K. L. STOLL.

THE INFLUENCE OF A PITUITARY SOLUTION ON INTRA-OCULAR TENSION. L. E. KREMENCHUGSKAYA, Russk. j. opht. **8:** 334 (March) 1931.

The author applied a pituitary solution, an extract of the middle and posterior lobes of the pituitary gland, in various forms of glaucoma. The pituitary solution, similar to epinephrine, raises the blood pressure by narrowing the lumen of the blood vessels, but the following dilatation is more gradual than after the use of epinephrine.

Twenty eyes were treated by subconjunctival injections of the pituitary solution, a 2 per cent solution of alipin being used as an anesthetic. Two of the patients suffered from acute inflammatory glaucoma, seven from chronic inflammatory glaucoma, six from simple chronic glaucoma, five from absolute glaucoma, and four had normal eyes. In those cases in which there was a return of hypertension, the injections were repeated a few times, and the dose was increased to 1 cc. Miotics had no, or very little, effect on most of the cases before the pituitary solution was applied. No general or local reaction was observed in any case.

The author recommends the pituitary solution as an auxiliary treatment only, because in most of the cases its effect was neither permanent nor lasting. In all cases the miotics became effective again after injections of the pituitary solution. The solution is most effective in acute glaucoma, as the ciliary veins contract, the cloudiness of the cornea diminishes, the tension decreases considerably, and the vision and fields improve. The pupil, however, remains dilated. The action of the pituitary solution is less marked in chronic inflammatory glaucoma, and it is very slight in simple and absolute glaucoma.

O. SITCHEVSKA.

Refraction and Accommodation

THE ESTIMATION OF THE TOTAL REFRACTIVE ERROR WITHOUT A CYCLOPLEGIC. D. SMITH, Am. J. Ophth. **14:** 498 (June) 1931.

The author discusses the control of accommodation. The cyclodamic method attempts the complete relaxation of accommodation. This is estimated by refracting the patient to 6/60 and then deducting 1.50 diopters. Skiascopy with distant fixation is also used. The author gets the patient's history, but does not test the vision. An accurate keratometer reading is made, and a brief ophthalmoscopy is performed. The total astigmatism is then found by skiascopy with distant fixation. Skiascopy is continued and prolonged, and if it is done at ⅔ meter, it saves a change of lenses for the next test, as this represents + 1.50. This is recorded as the total error. These lenses are kept on, and subjective tests are made. The patient should see 6/60. Both eyes are tested together objectively and subjectively. Each eye is then tested separately, and if vision of 6/60 is obtained with one eye, that eye is excluded by

adding a + 0.50 or + 1.00 sphere. Should vision be better than 6/20, the spheres are increased until 6/60 is obtained. Similar tests are made at the 6/12 level of blurred vision. The skiascopic, the 6/60 and the 6/12 records are then compared, and if they agree, the author assumes that they represent total relaxation. If they do not agree, reexamination or cycloplegic refraction is done.

W. S. REESE.

THE MYOPIC PROCESS. O. WERNICKE, Arch. de oftal., Buenos Aires **6:** 261 (May) 1931.

The author distinguishes between myopia as a refractive error and a condition that he calls the "myopic process." This process leads to ocular ectasia, which may occur at different situations and is due to a diminished resistance of the fibrous coat of the eye, with an absence of inflammatory manifestations, a preservation of transparency and a lack of cicatrization. When situated at the posterior pole of the eye, it coincides with the refractive error.

In mild cases, when situated posteriorly, the process can be determined only by careful ophthalmoscopic measurement by the direct method. When occurring equatorially, it can often be perceived under the conjunctiva; it gives rise to no subjective symptoms. It occurs more frequently than is usually believed. In the ciliary region, it affects the function of the ciliary body, of the suspensory ligament of the lens and of Schlemm's canal, giving rise to symptoms quite distinct from myopia. At the anterior pole is found keratoconus, which is identical in nature. In this connection, the author refers to the presence of Fleischer's ring (a scarcely perceptible ring of pigment at the base of the cone), indicating disintegration. On account of a lesion of the corneal nerves from the corneal thinning, one finds anesthesia of the apex (Axenfeld). When located at the optic nerve entrance, one finds scleral ectasia at this point with injury to the optic nerve fiber similar in origin and nature to that of the sensitive corneal nerves in keratoconus.

C. E. FINLAY.

Retina and Optic Nerve

ANGIOMATOSIS RETINAE. A. J. BEDELL, Am. J. Ophth. **14:** 389 (May) 1931.

The author states that angiomatosis retinae has been reported less than a hundred times. In some cases it is associated with widespread cystic degeneration, particularly of the brain, so that skilful ophthalmoscopy is necessary. Clinically, there are three types, all of which eventually look almost alike. The disease is probably most common in the third decade of life. Fulness of the retinal veins first appears, followed by a retinal edema and subretinal flecks of exudate, which soon become subretinal sheets. At this time angiomas appear in the periphery of the retina, usually to the temporal side, accompanied or preceded by detachment of the retina. Complete detachment with secondary glaucoma usually follows. The exudate is beneath the vessels and most often appears on the temporal side. The detachment may be isolated in the extreme periphery; there may be a sector defect near the disk;

a single, large, bulbous separation, or several detachments giving the impression of multilobular cysts. The blood vessels show irregular caliber, fusiform dilatation, beaded contour, loops, spirals and glomeruli. The veins seem to undergo the greatest change.

Three cases are reported, in one of which the disease was bilateral. In addition to the notes on these cases over a period of from two to three years, stereoscopic fundus photographs are given, showing the various phases of the disease. The author gives a historical review of a number of cases, starting with the first case reported by Fuchs. An extensive bibliography is appended.

W. S. REESE.

CYSTIC ANGIOMATOSIS OF THE RETINA. J. MAWAS, Presse méd. **39:** 985 (July 4) 1931.

By the use of the ophthalmoscope certain general diseases may be studied, but none is more readily recognized than cystic capillary angioma. Its progress may be followed by frequent examinations and photographs. Ophthalmologists have come to know this condition as von Hippel's disease. The author had the unusual opportunity of being able to study microscopically such a case, this being the first time a histopathologic report has been published in the French literature. The clinical symptoms and ophthalmoscopic observations are discussed. Sections show angiomatous caverns; the large vessels are distended like a balloon and are united by fibrous stroma. They are veritable vascular sinuses. The retina shows an intense proliferation of the neuroglia with multiple cystic degeneration. The author believes that Lindau's disease and von Hippel's disease are one and the same condition pathologically. Four excellent photomicrographs in colors and two drawings of the fundi accompany the article.

L. L. MAYER.

OCCLUSION OF THE CENTRAL RETINAL ARTERY. G. TIRELLI, Arch. di ottal. **38:** 227, 1931.

A man, aged 58, with a blood pressure of 205 systolic and 145 diastolic, had noted transitory attacks of reduced vision for one year, followed by sudden complete loss of vision in one eye. He was examined one hour after the defect was first noted and showed the typical picture of closure of the left central artery, with no perception of or reaction of the pupil to light. One-tenth gram of acetylcholine was injected at once, and within two hours the lower vessels were seen to be dilated slightly. Four hours later this dilation was more marked, and vision of 1/10 was present. Daily injections of this amount of the drug were given for twelve days, during which time the lower vessels returned to normal size, while the upper vessels remained very small and edema of this part of the retina persisted. Two days after the first injection vision was 4/10+, and a fair field was present in the upper half.

The seat of the occlusion was evidently at the origin of the superior branch of the central artery which bifurcated behind the lamina cribrosa. The involvement of the macular region was due to its being supplied with only one papillomacular vessel, which arose from the superior temporal vessel. This evidently nourished more than half of the macu-

lar region, a smaller branch from the inferior temporal vessel being less important, which accounted for the partial central scotoma.

A previous vascular lesion had produced a motor disturbance of speech, and the author considers that both lesions were probably due to endarteritis complicated by spasm of the inferior branch. He considers that the use of acetylcholine as a powerful vasodilator was important in relieving this vascular spasm early enough to prevent permanent damage to the retina supplied by the inferior artery.

S. R. GIFFORD.

RHINOGENOUS RETROBULBAR OPTIC NEURITIS. E. P. PORCEL, Arch. de oftal., Buenos Aires **6:** 276 (May) 1931.

The author presents a review of the clinical features of acute and chronic retrobulbar optic neuritis and of different etiologic factors. He mentions cases originating from lesions of the sphenoidal sinus, and stresses the benefit obtained by Wright, Sluder, Segura and others by opening the sphenoidal sinus, even when no manifest lesion was present (vacuum sinusitis). He reports an acute case affecting the left eye without any etiologic antecedents. Visual acuity was reduced to 1/20, with a central scotoma and concentric contraction of the visual field. Examination of the nose showed septal deviation and swelling of the nasal mucous membrane. Roentgen examination revealed a large sphenoidal sinus surrounding the sella turcica. On opening the sinus by the endoseptal route, Segura found swelling and edema of the mucous lining of the sinus. Rapid improvement followed.

C. E. FINLAY.

ANGIOID STREAKS OF THE RETINA. PSEUDOXANTHOMA ELASTICUM OF THE SKIN—A DISEASE ENTITY. MARCHESANI AND WIRZ, Arch. f. Augenh. **104:** 522, 1931.

The authors describe the typical picture of angioid streaks in the retina first presented by Planges in 1891. Repeated observations over a period of years have shown that these cases are probably not congenital, since the picture of the fundus changes considerably and the patient's vision usually deteriorates. They cite the frequency with which hemorrhages are found. These may appear in any of the layers of the retina, with preference for the macular region, and are apparently spontaneous. Fresh exudates were never seen in the four cases reported by the authors, i. e., the changes described by Coppez and Davis which led to the term retinitis exudativa with angioid streaks. A proliferation of connective tissue in the macular region seemed rather characteristic, and in the cases in which this occurred central vision was considerably reduced.

The authors discuss the rôle of trauma in the production of angioid streaks, having found a history of trauma in 50 per cent of their cases. The various theories that have been advanced to explain the peculiar ophthalmoscopic appearances are discussed. The disease entity known as pseudoxanthoma elasticum is a rare dermatologic disease first described about 1896. It consists of fine yellowish or coffee-colored dots and stripes of different size just under the skin, which tend to raise it

up in slight folds. The cutaneous condition is apparently due to a degenerative process in the elastic tissue of the skin itself.

Having found angioid streaks in the retina in one case of pseudoxanthoma elasticum, the authors investigated the other cases of this condition and found in every case of angioid streaks a corresponding pathologic condition in the skin. There is apparently a primary degeneration of elastic tissue all over the body, not only in the skin but in the lamina elastica of the choroidea. The angioid streaks are seemingly a manifestation of the disease at a later stage. F. H. ADLER.

GLIOMA OF THE OPTIC NERVE. R. SEEFELDER, Wien. klin. Wchnschr. **44:** 838 (June 26) 1931.

Glioma of the optic nerve has become, in late years, the tumor of prime importance of the optic nerve, through the work of Fischer, Fleischner and Schurer, Lohlein, Sattler, Hidano, Ablesdorff, Musial and others. Two cases, which were reported by Hidano, have been found in the author's clinic in a period of eleven and one-half years, during which about 60,000 patients were examined. The author wishes to report further on these cases. He concludes with Sattler, who reviewed the literature up to 1929, that local relapse does not occur, and in the majority of cases a later loss of general health does not appear.

A new case of bilateral glioma of the optic nerves is reported with autopsy observations. The pathologic examination proved that the tumors had an intracranial origin, which is seldom found. A bibliography accompanies the article. L. L. MAYER.

Trachoma

THE BACILLUS OF NOGUCHI—DOES IT GIVE A SPECIFIC INTRADERMAL REACTION IN TRACHOMA? R. C. MIKAELIAN, Rev. internat. du trachome **8:** 64 (April) 1931.

Fifty patients with trachoma and fifty controls without trachoma were investigated. Two types of antigens were used: (1) an emulsion of Bacterium granulosis and (2) a filtrate of the same emulsion. The control solution was sterile physiologic solution of sodium chloride. The methods of preparing these antigens are outlined in detail. The reactions were divided into three phases. Because of the like reactions obtained in the controls the author concludes that the intradermal reaction does not argue for the specificity of the B. granulosis for trachoma.

L. L. MAYER.

MEDICAL TREATMENT OF TRACHOMA. SCHOUSBOÉ, Rev. internat. du trachome **8:** 70 (April) 1931.

This is an extensive article, to which a good bibliography is appended. It should be of value to all who treat patients with trachoma.

L. L. MAYER.

THE ETIOLOGY OF TRACHOMA. MARIE FISCHER-ASCHER, Arch. f. Augenh. **104:** 441, 1931.

Cultures were taken from sixty cases of trachoma and from five children with well marked folliculosis, according to the technic of Noguchi for isolating Bacillus granulosis. The cases of trachoma were all typical. In eleven of the sixty cases B. granulosis was isolated, and of the isolated organisms transplants were successfully made from six for several generations. B. granulosis was never recovered from one case of folliculosis.

Attempts to obtain satisfactory complement-fixation and agglutination tests were unsuccessful. Inoculations of nine Macacus monkeys with cultures received from the Rockefeller Institute were successful in only two cases in producing conjunctivitis with papillary hypertrophy. In one of these cases the uninoculated eye of the same animal contracted the disease. The conjunctival infection of these animals did not correspond with human trachoma in either its clinical picture or its course, but this does not disprove the etiologic significance of B. granulosis, for monkeys may not show the typical reaction of man to the bacillus, and also the particular strain employed may have lost some of its virulence.

F. H. ADLER.

Tumors

NASO-ORBITAL EPITHELIOMAS. H. ABOULKER and A. GOZLAN, Ann. d'oto-laryng., April, 1931, p. 381.

The authors report eight cases seen in recent years with satisfactory treatment by the combination of two procedures, surgical and radium therapy. They list the following essential characteristics of the epitheliomas that they have seen: (1) the extensive tendency of the lesions, (2) their tendency to return locally, (3) a constant integrity of the ganglion cell layer even in advanced cases, (4) slow progress (from four to ten years) and (5) lack of metastasis.

Their technic consists of radical exenteration followed immediately by buried radium therapy. Attempts to save the eyeball for visual function have not met with success. No plastic repair is attempted at the time of the initial operation. Photographs of the cases accompany the article.

L. L. MAYER.

CONJUNCTIVAL INCLUSION CYSTS. M. CORRADO, Ann. di ottal. e clin. ocul. **59:** 445, 1931.

A man aged 66 had received a slight cut of the conjunctiva fifteen years before examination. Fourteen years later a cyst began to develop at this site, and when the patient was seen by the author a year later it had grown to the size of a kidney bean. It was at the inner limbus, extending almost to the caruncle and encroaching slightly on the cornea. Sections showed a cyst with two communicating cavities lined with stratified epithelium like that of the bulbar conjunctiva.

In a second case, a similar cyst developed in the semilunar fold. Sections showed it to be lined with stratified, cuboidal and cylindric epi-

thelium in various parts with some mucin-secreting cells. A number of processes covered with cylindric epithelium extended into the cyst. It was considered probably to be of traumatic origin, though no history of injury was given.

Cirincione's classification of conjunctival cysts and the records of a number of similar cases are reviewed. S. R. GIFFORD.

Sympathetic Ophthalmia

THE EVOLUTIONARY CHARACTERS OF SYMPATHETIC OPHTHALMIA ENDING IN CURE. H. VILLARD, Arch. d'opht. **48**: 197 (March) 1931.

Villard describes three cases of sympathetic ophthalmia characterized by severe recurrences of iridocyclitis in the sympathizing eye after long periods of apparent cure. Whatever the cause and mechanism of cure may be in these cases, he thinks that three lessons can be drawn from them. The first is that in those subjects likely to be cured the disease does not end suddenly and at once. Before reaching this state, the course is interrupted by temporary recurrences of inflammation situated exclusively in the iris. The attacks of iritis are separated by intervals of quiet of varying duration—sometimes of several months, or more than a year. The second lesson is that the patient must be warned of the dangers of a recurrence, even after long periods of apparent cure. The third is that these inflammatory recurrences do not have a bad prognosis, as they do not interfere with a final cure. S. B. MARLOW.

Toxic Amblyopia

AMAUROSIS DUE TO ETHYLHYDROCUPREIN. REPORT OF CASE AND CURE. PAULINA STANOWSKY and SAUL I. BETTINOTTI, Arch. de oftal., Buenos Aires **6**: 589 (July) 1931.

After reference to the frequent use and mode of employment of ethylhydrocuprein in the treatment for pneumonic purulent pleurisies and occasional ocular lesions that may lead to total amaurosis, the authors report a case in a child 2 years of age; ethylhydrocuprein was employed in injections in relatively small doses, but washing out of the pleural cavity with ethylhydrocuprein was prolonged for a long period, and after sixty days mydriasis, pallor of the optic disk and loss of sight developed. The employment of ethylhydrocuprein was suspended and acetylcholine chloride and strychnine sulphate were given internally as a retinal vasodilator and nerve stimulant. Pilocarpine was instilled locally. After two months of treatment, the pupillary reaction and sight had been recovered and the retinal vessels had returned to their normal caliber.

The ocular symptoms dependent on quinine or ethylhydrocuprein intoxication can be classified under two heads: (1) those occurring without any appreciable ophthalmoscopic lesion, and (2) those occurring with lesions, in the form of (*a*) contraction of the retinal vessels and pallor of the optic disk and retina, and (*b*) narrowing of the arteries, tortu-

osity and dilatation of the veins and papillary edema with occasional hemorrhages. The subjective symptoms consist of sudden blindness with symptoms of retinal ischemia.

The modus operandi by which blindness is brought about has given rise to much discussion; it seems to be of a similar nature to that occurring after severe loss of blood, i. e., by means of a retinal ischemia from vascular spasm, which manifests itself by retinal and papillary pallor and contraction of the arteries. This is deemed sufficient, by some authors (Uhthoff and Aberdoff) for the production of lesions of the ganglion cells and axis cylinder degeneration, while others (Velhagen and Foster) believe that some toxic action on these tissue elements is necessary, as in their cases and experiments changes were observed early in the microscopic structure of the tissues, which is not explainable solely by the vascular theory.

As regards treatment, the authors consider the essential indications to be: suppression of the use of the drug, with the employment of vasodilators and nerve stimulants.

Rollet recommends the use of atropine as a vasodilator. In the reported case the authors did not utilize it, owing to the susceptibility of the child to the drug, preferring instillations of pilocarpine with a view to favoring endo-ocular circulation, and injections of acetylcholine chloride to stimulate the peripheral circulation. Simultaneously they used strychnine.

The authors conclude that ethylhydrocuprein can be employed only in moderate doses with careful and constant watching of the vision, pupillary reaction and ocular fundus and with immediate suspension of the drug at the first sign of a toxic action followed by immediate use of vasodilatatory drugs.

C. E. FINLAY.

Society Transactions

EDITED BY DR. GEORGE S. DERBY

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Feb. 19, 1931

H. MAXWELL LANGDON, M.D., *Chairman*

A CASE OF CONGENITAL CATARACT WITH UNUSUAL VISUAL ACUITY AND PSEUDO-ACCOMMODATION THIRTEEN YEARS AFTER OPERATION. DR. WILLIAM ZENTMAYER.

This patient, when a girl 9 years of age, was referred to me by Dr. R. T. M. Donnelly in May, 1917. The history of the case leaves it uncertain as to the type of cataract originally present. After an illness of several weeks the patient accidentally discovered that she had very poor sight in the left eye. Previous to the illness she attended school and had no trouble with her eyes.

When she was first examined there were diffuse opacities throughout both lenses. By November, 1917, the left lens was opaque throughout. Two needlings and a linear extraction were performed. In January, 1918, under atropine, vision with a + 12 sph. + 1.25 cyl. ax. 165 degrees was 5/7.5. In March, 1918, without atropine, vision with a + 12 sph. was 6/6 in part. The patient read type 0.50 at 10 cm. with distance glasses. The right lens was needled but once, in January, 1919. In April, with a + 13 sph., vision was 6/6, and the patient read type 0.75 with difficulty with this glass. In December, 1920, vision in the right eye having fallen to 1/120, the Ziegler V-shaped capsulotomy was done. Following this, vision with + 10 sph. + 2.50 cyl. ax. 105 degrees was 6/5. The conditions that obtained at the last examination were:

O.D. + 10 sph. + 1.75 cyl. ax. 100 degrees 6/4; 5′ card; Dr. Cowan's card, 6.5, in part.

O.S. + 10 sph. + 1.50 cyl. ax. 70 degrees, 6/3, 5′ card; Dr. Cowan's card 6/5 (one mistake).

There were orthophoria and esophoria for distance, 7 degrees of exophoria at 33 cm., bar reading, and full binocular vision, as shown by tests including Verhoeff's binocular test.

Other findings were: With distant correction and the eye wide open, O.D., type 1, p.p. 17 cm.; O.S., type 0.50, p.p. 13 cm.

With distant correction and nipped lids, O.D. type 0.50, p.p. 13 cm.; O.S., type 0.37, p.p. 11 cm.

Without glasses, O.S., type 1, p.p. 14 cm.

The addition of a — 0.25 sph. to the patient's distance glass reduced her vision almost a line.

Ophthalmoscopic examination gave the following results. O.D., with a + 16: The pupil was almost round. A fine synechia was seen at 12 o'clock. A hair line of capsule showed along the nasal border of the iris. The pupil seemed otherwise clear. The disk was vertically oval, with a clearcut edge. A cilioretinal vessel appeared toward the outside. O.S.: The pupil was round. There was a crescent of dense white capsule beginning at 1 o'clock and extending around the nasal and lower border of the pupil to 4 o'clock, with a vacuolated rim of tissue between this and the pupillary center. Beyond, on the temporal side, the pupil was perfectly clear. The disk was seen rather dimly, but the rest of the fundus plainly.

A biomicroscopic examination was made by Dr. Alfred Cowan. O.D.: There was a bulging forward of the vitreous through the pupillary space. This was covered by an extremely thin, transparent membrane. During contraction of the pupil the curvature of this vitreous front increased, but it is unlikely that this aided materially in the patient's ability to see near objects. The accommodative effect seemed to be due almost entirely to partial closure of the lids. O.S.: The pupillary space contained a dense white sheet of remaining capsule in which there was a tiny opening, which probably acted as a stenopeic aperture. The evidence of this is in the patient's ability to see clearly at certain times without glasses.

A Case of Spontaneous Cyst of the Iris. Dr. Edward A. Shumway.

In a woman, 56 years of age, who had been operated on for carcinoma of the rectum, a cyst of the iris appeared within two years. It produced no discomfort or disturbance of vision. There was no history of traumatism or operation. The cyst was transparent, the anterior wall being thin and crossed by fibers representing the iris stroma; the posterior wall was in contact with the pigment layer of the iris. The cyst had forced the lower part of the iris from its ciliary border, and was in contact with the cornea below, without producing any cloudiness of that structure.

Dr. Shumway discussed the theories as to the origin of spontaneous iris cysts in the anterior part of the iris, in distinction from those developing from the epithelium of the posterior layer of the iris and those arising from an attachment of the ciliary processes to the posterior iris surface (Tertsch's classification), all of which are to be distinguished from the more common cysts which arise from an ingrowth of epithelium into the anterior chamber after traumatism or operation.

In view of the complication of a tumor of the rectum, the eye was searched carefully for metastasis, but none could be found. It was decided not to remove the cyst by operation, because of the patient's age, the complicating inoperable carcinoma and the absence of ocular discomfort.

DISCUSSION

Dr. W. S. Reese: Dr. Reese said that some time before, a case of this type appeared at the Will's Hospital and from slit-lamp observations Dr. Cowan made a diagnosis of cyst of the iris. Dr. Reese had felt that the lesion was a tumor. There was no history of injury, as

he recalled it, and the cyst differed from that in Dr. Shumway's case in that the color was consistent with that of the iris throughout. There was definite elevation of the cornea at the site of the cyst, which was in practically the same situation as in this case. Dr. Reese made an attempt to remove it and got into difficulty, discovering the cornea to be abnormally thin, so much so that he desisted and placed a conjunctival flap over the whole mass. The eye healed uneventfully. He asked Dr. Shumway whether there were bulging and thinning of the cornea at the site of this cyst.

DR. EDWARD A. SHUMWAY: Dr. Shumway said that, so far as he knew, thinning of the cornea had not been reported in the cases examined anatomically, but opacification of the cornea was common. In operating it was necessary to remove the entire cyst with the part of the iris involved to prevent recurrence. With simple puncture the cyst promptly filled up.

MELANOSIS OF THE ANTERIOR SEGMENT OF THE GLOBE WITH IRREGULAR ELEVATIONS ON THE IRIS. DR. H. MAXWELL LANGDON.

Melanosis of various parts of the body is of fairly frequent occurrence in the form of moles, nevi or plaques. It occurs mostly in brunettes, and possibly has some relation to the formation of malignant tumors, as Coats found seven instances of melanotic sarcoma in twenty-six cases of diffuse melanosis of the uvea.

Heine reported nevus and sarcoma in juxtaposition in the iris with evidence of a transition from the benign to the malignant form, though Fuchs thought the change from nevus to sarcoma in the iris had not been shown with any certainty and felt that melanosis is merely an incident of sarcomatous growths.

In the eye, melanosis is usually unilateral, and varies a great deal in its extent from a few pigmented spots in the iris to a general pigmentation of the lids, sclera and uveal tract.

The condition was thoroughly described by Bourquin, and in March, 1930, Goldstein and Wexler published an exhaustive study of a case in Mount Sinai Hospital, in New York, with the microscopic report of one of the eyes. This case was associated with neurofibromatosis, many pigmented skin moles and acromegaly.

The eyes showed hyperpigmentation of the uveal tract, the posterior pigment layer being almost double the normal thickness, with protrusion at the pupillary margin. Irregular masses were noted on the anterior surface of the iris, with hyperplasia of the anterior iris endothelium and irregular pigment masses through the stroma. The pigment excess was also in the ciliary body, including its process, and in the pectinate ligament. There was no evidence of round cell infiltration, new vessel formation or karyokinesis.

The source of this pigmentation in the iris is difficult to explain. Fuchs objected to its being called pigmented nevus owing to the absence of nevus cells; this places the source among the pigmented fixed tissue cells. These may be the endothelial ectodermal cells or the chromatophores of the stroma, which are believed by most authorities to be mesodermal in origin, and this seems to be the most likely source.

Dr. Reese believed this to be the source of the pigment in his case of melanosis. Treacher Collins believes that these mesodermal cells have a phagocytic property, taking up melanin from degenerating epithelial cells.

The case reported is that of a boy (J. DeL.), aged 3½ years, the third child in a family of four children, the oldest 13 years and the youngest 1 month of age. None of the others was similarly affected, nor were the parents. The condition was noticed first about two months before presentation, but had probably been there for a much longer time.

The pigment involved a ring of sclera about from 4 to 6 mm. out from the limbus and the iris, the lids and the rest of the uveal tract being quite normal. The right eye had a brownish-gray iris and seemed normal in all respects. As near as could be told in a child of this age, the function of each eye was normal.

The affected sclera looked as though it had been peppered with pigment granules, and this description also fairly well applied to the iris.

This structure in daylight was a dark sooty brown with granules thickly peppered over its whole surface, the crypts being entirely filled in and the overlying pigment so thick that one had a feeling of not looking at the iris itself but at the pigment on the iris.

The iris in this case, as in Friedenwald's and in several others, showed irregular protuberances or wartlike growths over its surface. George Coats used the term "golf ball" iris, in describing a case of his. In Goldstein's case, the iris was the site of multiple melanotic nodules. In the case here reported the melanin did not seem to be in the nodules but on them, except for their topmost parts which, under the corneal microscope, seemed to be free from pigmentation and to resemble normal iris tissue.

DISCUSSION

DR. G. E. DE SCHWEINITZ: Dr. de Schweinitz, who had had the opportunity of examining Dr. Langdon's and Dr. Friedenwald's patient (a girl about 16 years of age), expressed the opinion that the lesions were probably identical in nature, although not exactly similar in manifestation.

The refractive error of Dr. Friedenwald's patient was a mixed astigmatism; the visual acuity was markedly improved when the patient tilted her head toward either shoulder and gazed obliquely. In these circumstances a constant lateral nystagmus, ordinarily present, practically ceased.

DR. ALFRED COWAN: Dr. Cowan said that the thing that struck him most in this case was the gradually diminishing size of the elevations from the pupil toward the periphery of the iris. Those nearest the pupillary border were best developed. They appeared as spherical elevations with tops of fuzzy material that did not look like iris tissue and certainly was not pigment; it was nearly colorless. These elevations decreased in size until at the periphery they were like tiny tips. The regular distribution over the surface of the iris and the decrease in size and maturity from the pupil outward were remarkable.

DR. H. MAXWELL LANGDON: Dr. Langdon said, in reference to the subnormal visual acuity in Dr. Friedenwald's case, that in most of the cases reported, there was no change in the visual function.

In Goldstein's case decided loss of vision occurred and there was difficulty in studying the condition during life. This patient died in the hospital. The eye was secured for section and a complete study was made.

A Note on Radiational Cataract. Dr. G. E. de Schweinitz and Dr. B. F. Baer.

Describing radiational cataract as one that is caused by any form of radiation that is "absorbed in quantity by the lens," Dr. de Schweinitz and Dr. Baer made reference to the three chief varieties of this lesion, namely, those due to exposure to infra-red rays (glass-blower's cataract, etc.), to ultraviolet rays (rather uncommon) and to radium and x-ray emanations (comparatively fairly frequent). However, they confined their remarks chiefly to that form which may be caused by radium used as a therapeutic agent for the destruction of an epibulbar sarcoma (illustrated by the record of a case).

The cataract may be regarded as a special type, and in most instances begins at the posterior cortex in an oval or disklike form, rather granular in appearance and containing fragments of crystallized lens protein. Beneath the anterior capsule a delicate layer of opacity and also vacuoles may form. The lens structure between the anterior and the posterior cortex is at first unaffected.

The observations of a number of authors, for instance, Rohrschneider, Schnyder, Meesmann and Zentmayer, confirmed those made by Dr. de Schweinitz and Dr. Baer, concerning not only radium but also x-rays. The character of the cataract is the same no matter which form of radiation causes it.

In the patient described, the eye exhibited another complication, namely, paresis of the outer half of the iris adjacent to the area originally occupied by the sarcoma.

The authors also referred to the invariable development of epibulbar conjunctival telangiectasia as the ultimate result of the radiation—a characteristic phenomenon, as originally pointed out by Birch-Hirschfeld.

They also described the development of quiet iritis in one patient successfully treated with radium for epibulbar sarcoma. In this connection they made reference to Flaschentrager's observation, quoted by Koby, of vascular lesions (dilatation, thickening and cleavage of the walls) in the ciliary body of the eye of a patient who had been irradiated for cancer of the breast.

Such being the case, similar vascular lesions in the present case might account for the iritis, which, however, rather rapidly subsided under the influence of the usual treatment.

The authors' patients had been successfully treated by means of radium emanations by Drs. Pancoast and Pendergrass of the roentgenologic department of the University Hospital. The patients were always warned that a sharp reaction might follow the radiation, and that some permanent disturbance of vision might result.

DISCUSSION

Dr. E. P. Pendergrass: Dr. Pendergrass said that the occurrence of telangiectasia of the conjunctiva following irradiation is usually evidence of overirradiation. Irradiation usually causes endarteritis obliter-

ans of the blood vessels supplying the part, and thereby destroys the normal nutrition of the treated area; in an effort to overcome this, nature forms new blood vessels.

In the treatment for melanotic lesions of the cornea, the tendency is to overirradiate rather than underirradiate because of the seriousness of the prognosis.

In the cases reported by Dr. de Schweinitz and Dr. Baer this type of irradiation was used. Some of the rays were penetrating and some were superficial. Recently Dr. Pendergrass has employed superficial irradiation so as to prevent a possible deep effect.

It is a little difficult to explain the formation of a cataract such as that described by Dr. de Schweinitz. If the cataract was formed following a disturbance in nutrition of the blood vessels of the ciliary body, one could easily understand how irradiation might produce it. It has been said that disturbance of the blood supply of the ciliary body would not cause changes in the posterior cortex of the lens. If this is true, one would have to explain the effect in some other way, and a possible explanation is the following:

Absorption of the superficial rays causes changes that subsequently lead to telangiectasia. The more penetrating, or gamma, rays might be absorbed in the region of the posterior cortex of the lens, and account for the changes observed by Dr. de Schweinitz and Dr. Baer. This explanation is theoretically possible, but is probably less tenable than the theory that changes are produced in the posterior cortex secondary to the disturbance in the blood supply of the ciliary body.

Dr. Edward A. Shumway: Dr. Shumway said that he thought the changes in the lens might be due to the disturbances in the vessels of the ciliary body, and consequent interference with the nutrition of the posterior part of the lens, just as in disease of the uveal tract in the posterior part of the eye. There are no cells lining the posterior capsule of the lens such as are present on the anterior capsule, and proliferative cell changes therefore could not be produced by radium in this position.

Method of Accurately Localizing Tears in Retinal Detachment. Dr. Alfred Cowan and Dr. L. F. McAndrews.

The patient is seated 0.5 meter from a tangent screen and is told to rotate his eye laterally, fixing a point about 50 degrees from the center of the screen. The examiner then locates the lesion with an ophthalmoscope. An assistant, with a meter stick or a piece of string, projects the line of direction found by the examiner back to the tangent screen. The angle found by the examiner must be corrected to allow for the bending of the rays of light. This is done by deducting one-fourth from the angle, in both the vertical and the horizontal meridians. This corrected point is now placed on the tangent srreen.

To find the corresponding point on the sclera, one can use a scaled perimetric chart. The chart represents the entire retina projected onto a flat surface, its center corresponding to the fovea, and the 90 degree circle to the ora serrata. On this chart are vertical and horizontal lines, drawn 4 degrees apart. Each of these 4 degree squares is equivalent to 1 mm. on the retina. The point found on the tangent screen is

transferred to this perimetric chart. Considering that the 90 degree circle corresponds to the ora serrata and that the latter is 8 mm. behind the limbus, the correct distance of the tear from the limbus can be quickly and accurately estimated.

DISCUSSION

DR. L. C. PETER: Dr. Peter said that the plan submitted by Dr. Cowan and Dr. McAndrews for localizing tears in detachment of the retina is perhaps less complicated than the majority of the other methods that have been offered. There is no difficulty whatever in locating the tear with reference to the corneal meridian. The difficulty in all cases rests in being able to determine properly the depth of the tear.

A fact that all of these methods cannot definitely determine is the location of the tear when the fluid is withdrawn and the retina is again in contact with the sclera. It matters little how accurate a method may be in locating the tear while the fluid is in place; none of the methods can tell one definitely where the tear will be when the cautery is to be applied.

Dr. Peter has performed a good many Gonin operations, and has been fortunate enough to strike the tear in a great majority of cases, but it is only by careful observation with the ophthalmoscope and by shrewd guessing that one can even approximate the location of the tear. He finds, therefore, that good judgment is important.

If one will remember that the average disk is about 1.5 mm. in diameter, the size of the tear can be approximated with reference to the size of the disk; by careful measuring in disk diameters from the disk forward to the tear and by remembering the size of the cornea and the distance of the ora serrata from the limbus, one can approximately determine the location without the use of any one of the many complicated methods that have been suggested.

It should also be remembered that the position of the tear in the retina when the patient is in an upright position is not the same as when the patient is in the recumbent position, as when he is on the operating table. Any method that is employed should be practiced with the patient in the recumbent position.

A. G. FERWELL, M.D., *Secretary*

March 19, 1931

H. MAXWELL LANGDON, M.D., *Chairman*

BITEMPORAL PARACENTRAL SCOTOMA. DR. C. E. G. SHANNON.

Dr. Shannon reported a case of bitemporal paracentral scotoma in a man, aged 36. Following injections of serum from typhoid, dysentery and cholera all in one day in September, 1929, he suffered from blurred vision and severe pain in his eyes. A diagnosis of glaucoma was made, and he was given a weak solution of physostigmine (eserine) for constant use.

Examination of his eyes revealed no abnormalities of the anterior segment. Tension by tonometer was 20 mm. of mercury in the right eye and 19 mm. of mercury in the left eye. The ophthalmoscopic examination gave negative results.

With correcting glasses, a vision of 6/6 plus was obtained in each eye.

Form and color fields were within normal limits.

A small bitemporal paracentral scotoma was mapped out just temporal to the point of fixation in each eye. Fields taken at varying intervals for four months showed no change in the findings.

Urinalysis gave negative results. The Wassermann tests of the blood and spinal fluid were negative. Examination of blood showed a white count of 8,800; otherwise it was normal. A roentgenogram of the teeth revealed several bad teeth which were removed. A roentgenogram of the skull, made by Dr. Manges, was negative.

The diagnosis of small vascular lesions of the chiasm of toxic origin seemed justifiable. Syphilitic disease of the chiasm, which is frequently found in these bitemporal lesions, was discarded because of the negative Wassermann reaction of the blood and spinal fluid.

Pituitary disease was eliminated as the roentgenogram of the sella turcica failed to show any abnormalities, and further, there was no evidence of increase in size of the scotomas.

By elimination, it was concluded that the small vascular lesions were due to focal infection, abscessed teeth, or more probably the result of the injections of serum.

DISCUSSION

DR. G. DE SCHWEINITZ: Dr. de Schweinitz expressed the opinion that the bitemporal hemianopic scotomas depicted in the visual field charts of Dr. Shannon's patient were best explained by the presence of a small lesion in the chiasm at the position which the essayist had described, due to vascular obstruction, exactly as had been pointed out by Wilbrand and Saenger, and by Traquair.

The former authors believe that such a condition is due to syphilis. But Traquair, in his reference to this matter, stated that the vascular obstruction is "usually of syphilitic origin," and therefore he does not exclude other etiologic factors.

In the present instance, syphilis as a causative agent had been eliminated by the history and by all the usual tests. Hence it seems likely that this isolated chiasmal lesion may be ascribed to a localized vascular disturbance caused by the violent reaction that followed the various inoculations to which this patient submitted.

The defects in the visual field correspond exactly to those that Wilbrand and Saenger have described, and are likely to be permanent. The macula has been "spared," and the visual acuity is not interfered with.

DR. W. ZENTMAYER: Dr. Zentmayer said that he would like to report a case in which there were binasal paracentral scotomas in association with hemichromatopsia. The patient, a woman, was seen at the Wills Hospital in 1889 or 1890 and observed over a period of nineteen years. She was 27 years of age, quite stout, married and had two

children. She had had some symptoms that suggested pituitary trouble with disturbance of central vision such as Dr. de Schweinitz has described in these cases.

At first the field was full for form, but there was bitemporal hemichromatopsia. The field and vision remained unchanged for a long while, but later a bitemporal hemianopia for form as well as color was present.

The patient was examined many times, and ten years later binasal paracentral scotomas, larger than the ones described by Dr. Shannon, developed.

The case was extremely interesting, and in view of the pituitary symptoms, this being before the day of the x-rays, Dr. Spiller thought that she probably had a growth.

At the end of fifteen years she partly regained her temporal field, and central vision was improved from 6/15 to 6/9. The paracentral scotomas remained. She died of pneumonia, and no postmortem examination was made.

The only explanation seems to be that it was a lesion of the chiasm, and the growth had broken through the sella turcica, relieving pressure, and in that way the physiologic block was lifted.

NONGLAUCOMATOUS HALOS. DR. JOHN T. CARPENTER AND DR. CHAPIN CARPENTER.

The presenters said that halo vision is a prominent symptom of glaucoma. Its occurrence when glaucoma is absent is therefore of interest, and there are not many references in ophthalmic literature to the nonglaucomatous halos.

Their differentiation is important. even though halos are infrequent as sole indication of glaucoma. Elliot and Treacher Collins have laid emphasis on this point. Nonglaucomatous halos consisting of diffraction rings may be seen around lights by certain persons. These are also present when mydriatic has been instilled, and are due to edema of the corneal epithelium. Brundenill Carter reported similar phenomena in his own eyes, due to changes in the lens.

Other halos are seen normally after caustic applications to the lids, or when mucus is present in conjunctival sac. Fogged spectacles also produce them, and they have been present in iritis.

Incipient changes in the lens cause halo vision, particularly nuclear cataract due to the sclerosis. These halos were persistent in the cases reported by us.

Nonglaucomatous halos are smaller and less vivid than glaucomatous ones. Their size varies from 4 to 8 degrees.

Elliot suggests a test originated by Emsley in which, when a halo is seen around a candle placed 10 feet away, a card passed vertically in front of the pupil, if glaucoma is present, will, as the card crosses the pupil, only reduce the intensity of the halo. If the halo is due to cataract, the opposite portions of the halo disappear entirely. The explanation of this is that the corneal edema in glaucoma is more or less uniform and through any part of the cornea the halo would be seen, while in lens changes, such is not the case.

Glaucomatous halos vary in occurrence, depending on the presence or absence of corneal change, while those due to incipient changes in lens are constant.

Three cases were observed in which incipient cataracts of the nuclear type were present, and in which there was halo vision persistently noted by the patients. This did not vary, and in all the cases the tension was found normal with tonometer readings, fields normal, and the test suggested by Elliot proved the halos to be nonglaucomatous. Two patients were observed over a year without any alteration in the condition, except advancing lens changes, but without any glaucomatous changes in the nerves or visual fields.

THE HAZARDS OF ANTIFREEZE METHANOL. MAX TRUMPER, PH.D. (by invitation).

Dr. Trumper said that automobilists, and especially those working in service stations and in garages, should know of a danger to which they may be exposed from the presence of wood alcohol used as an antifreeze mixture in radiators of cars and trucks. Especially at this time of the year when, owing to the warmer weather, more of this wood alcohol will evaporate from the radiators, the danger of being poisoned by its vapors is greater than usual. Many do not realize that antifreeze methanol or methyl alcohol is the chemical name for wood alcohol. The containers of methanol sold to the public under many trade names are not always labeled as poisonous. Much is sold from barrels bearing no conspicuous poison label to protect the public. Automobilists have been further misled by labeling the product as a "completely denaturized alcohol" or as a "188 proof alcohol," omitting the word "wood." The coining of a variety of trade names is an old method of obscuring the presence of concentrated wood alcohol, the knowledge of which would impair its sale.

It is important to remember that both the new synthetic methanol and the old crude methanol are poisonous; the difference is that the latter when evaporated from radiators contained obnoxious warning odors. The new synthetic product has no odor and therefore the automobilist receives no warning when it is evaporating and he is breathing it. This danger is also serious for those who use methanol as fuel for their alcohol lamps or chafing dishes—a use that some dealers have recommended in order to increase sales. Methanol is quite as poisonous when inhaled into the lungs as when taken into the stomach.

Thus far the dangers inherent in wood alcohol or methanol have been considered by reason of its new uses in which it may be breathed into the lungs or gain entrance by way of the skin. The dangers involved from its misuse must not be overlooked, that is, its use as a drink. The United States Bureau of Mines recommends that "all antifreeze methanol be brightly colored" to avoid such misuse. This recommendation, in Dr. Trumper's opinion, will hardly be followed by all producers until legislation requires it of them. Were methanol obtainable only in drug stores, it would promptly be included under the laws governing the sale of all poisons, especially because it has a taste and odor somewhat similar to grain alcohol. In this connection it is encouraging to note an opinion rendered by the attorney general of the state

of Ohio which reads, "synthetic methyl alcohol may be sold in Ohio only by registered pharmacists." Dr. Trumper believed it important to warn the general automobile riding public to be on guard against the vapors of wood alcohol.

DISCUSSION

DR. E. A. SHUMWAY: Dr. Shumway said that Dr. Trumper's paper was timely, as it called attention to the fact that methanol was a methyl alcohol preparation, but he doubted if its use in automobile radiators would be dangerous, as the fumes would not get inside the cars to such an extent as to make much contamination of the air. Drs. de Schweinitz, Tyson and others have reported serious disturbance of sight in workmen shellacking the interior of large vats, and Dr. Tyson has reported cases in which women had been affected while varnishing lead pencils. In all instances methyl alcohol, or so-called Columbian spirits, was present in the varnish, but lack of ventilation in the vats or rooms was an important factor. A number of cases were on record in which carbon monoxide poisoning occurred in closed cars in the winter season from the escape of the gas into the closed sedans, from leaky exhausts or from defective heaters, but he could not see that this could occur from a solution in the radiator.

DR. G. DE SCHWEINITZ: After briefly referring to his own observations and others reported in the literature on blindness due to inhalation of methyl alcohol aided by absorption through the cutaneous surfaces, Dr. de Schweinitz pointed out that, so far as he was aware, in all these instances the subjects of this toxemia had worked where ventilation was entirely lacking, and he agreed with Dr. Shumway that in the presence of proper ventilation it was most unlikely that visual disturbances due to inhalation would occur.

He referred to the researches of Ward Holden and Birch-Hirschfeld, who had attributed blindness from methyl alcohol to nutritive changes in the ganglion cells of the retina. On the other hand, the retinal ganglion cells of dogs acutely and chronically poisoned by the administration of commercial methyl alcohol, during a rather elaborate research carried on at the University of Pennsylvania by Fewell, De Long and himself, failed to show even the slightest departure from normal. Similar negative results were obtained by Jonas Friedenwald and Felty in Baltimore. Also, in all these experiments there had been at no time any evidence of blindness or ophthalmoscopic change.

In Schwarzkopf's experiments the animals exhibited no ophthalmoscopic lesions, but microscopically, degenerated ganglion cells were found.

An effort to explain these contradictory results has been made by assuming that they depended on the kind of methyl alcohol employed—chemically pure methyl alcohol, commercial alcohol, etc.—or the deleterious influence has been attributed to an admixture of fusel oil.

Henry Smyths, at the laboratory of hygiene of the University of Pennsylvania, however, failed to find any fusel oil in any of the methanols he used in his experiments, which were performed on guinea-pigs whose retinas exhibited definite ganglion cell changes.

The late Dr. Harold Gifford attributed the blindness to a simultaneous action of wood alcohol on the ganglion cells and the optic nerve, and Jonas Friedenwald recently stated that this agent acts on the whole optic nerve.

Casey Wood and the late Dr. Frank Buller regarded methyl alcohol intoxication in human beings as a typical example of idiosyncrasy. Whether a similar idiosyncrasy exists among animals, he was quite unprepared to discuss or maintain. Evidently the whole subject remains as an interesting field for further research.

DR. E. A. SHUMWAY: Dr. Shumway added that the effect of methyl alcohol on the system was produced by the intermediate products of its decomposition before it was finally oxidized. Ethyl alcohol was immediately reduced to carbon dioxide and water, in the body, but methyl alcohol was first converted into formaldehyde and formic acid, which poisoned the organism, the one by interfering with the oxidizing efforts of the cells, and the other by withdrawing oxygen from them. It had been shown, moreover, that the previous ingestion of ethyl alcohol still further prolonged the removal of the formic acid from the body, delaying at times the appearance of the visual disturbance and the fatal issue.

News and Notes

EDITED BY DR. JOHN HERBERT WAITE

SOCIETY NEWS

Association for the Prevention of Blindness.—At the general assembly of the International Association for the Prevention of Blindness, Nov. 14, 1931, in Paris, Professor de Lapersonne, of France, was reelected president of the executive committee, and Dr. F. Humbert, of Switzerland, was reelected secretary general. It was announced at this meeting that a permanent secretariat will be established in the near future. Dr. Cridland, of Great Britain, speaking on the "Value of a Complete Investigation of the Causes of Blindness as a First Step in Prevention," suggested that, before a propaganda campaign was undertaken, better knowledge be obtained of the most frequent causes of blindness. He advocated uniform statistics on the causes of blindness in the different countries. This suggestion was accepted. Dr. F. Park Lewis, of Buffalo, vice president of the Association, among others, spoke on "Certain Rare Forms of Cataract of a Parasitic Nature Observed in Fish."

Annual Congress of the Ophthalmological Society.—The annual congress of the Ophthalmological Society will be held at Edinburgh on May 12, 13 and 14. The subject chosen for discussion is: "Senile Cataract, Preoperative and Postoperative Complications and Management." Will members who wish to take part in this discussion and read papers, kindly notify Mr. Humphrey Neame, 56 Portland Place, London, W.I., before March 30? The Bowman Lecture will be delivered by Professor van der Hoeve, of Amsterdam. The annual dinner of the Society will be held, probably in the College of Surgeons, on Thursday, May 12.

British Medical Association.—The Centenary Meeting of the British Medical Association is to be held in London on July 27, 28 and 29, under the presidency of Lord Dawson of Penn. The section devoted to ophthalmology will meet under the presidency of Sir J. Herbert Parsons.

German Ophthalmological Society.—The next meeting of the German Ophthalmological Society takes place in Leipzig on May 19 to 21.

GENERAL

Resolutions on the death of Dr. George S. Derby adopted by the Board of Managers and by the Ophthalmological and Otolaryngological Staffs of the Massachusetts Eye and Ear Infirmary, respectively:

The managers of the Massachusetts Eye and Ear Infirmary record with deep sorrow the death of Dr. George Strong Derby on Dec. 12, 1931. Dr. Derby came from a Salem family distinguished for many generations. His father, the late Hasket Derby, was, like the son,

eminent in ophthalmology and for many years a member of the staff of the infirmary. George Derby was appointed junior ophthalmic assistant surgeon in 1909, served in the different grades and was made chief of the ophthalmic service and professor of ophthalmology at Harvard in 1923. He served as major and lieutenant-colonel of the Medical Department of the Army with the American Expeditionary Forces during the World War. Dr. Derby's leadership in the Department of Ophthalmology and in the affairs of the Infirmary was of a high order. He was devoted in his service. He gave freely of his time and thought. His example and his insistence on thorough and conscientious work was of the greatest value. He inspired the younger men in his specialty. The care of the patient, the teaching of ophthalmology and research were never done better at the Massachusetts Eye and Ear Infirmary than during the period when George Strong Derby was chief of the ophthalmic service. It is therefore voted: That this resolution be inscribed on the Managers' records and a copy sent to the family of Dr. Derby.

(Signed) JAMES C. HOWE, *Secretary.*

The Ophthalmological and Oto-Laryngological Staffs of the Massachusetts Eye and Ear Infirmary greatly lament the death of Dr. George S. Derby. Dr. Derby was connected with the Massachusetts Eye and Ear Infirmary for twenty-eight years, as ophthalmic clinical assistant, ophthalmic assistant surgeon, ophthalmic surgeon, and finally, for the past seven years, as ophthalmic chief of service He always had the welfare of the Infirmary near to his heart, and gave close attention to every detail relating to the work of the institution. To him is chiefly due the present excellent organization of the ophthalmic service. His work here has received wide recognition. He saw to it that every patient was given all possible care, and he was equally zealous in the interests of the staff. His unsparing efforts in behalf of the Infirmary no doubt contributed to his untimely death. Dr. Derby gained the high estimation and esteem of every member of the staff. In his death the Infirmary, each member of its staff and the community at large have sustained an irreparable loss. The Ophthalmological and Oto-Laryngological Staffs extend their deepest sympathy to Mrs. Derby and all members of his family.

W. HOLBROOK LOWELL,
Secretary, Ophthalmological Staff.

FREDERICK L. BOGAN,
Secretary, Oto-Laryngological Staff.

Book Reviews

Kurzes Handbuch der Ophthalmologie. By F. Schieck and A. Brückner. Volume IV. Price, 165 marks. Pp. 874. Berlin: Julius Springer, 1931.

One of the outstanding features of this remarkable "Handbuch" is the promptness with which its volumes are appearing. The new volume is the fourth and contains: "The Diseases of the Conjunctiva, Cornea and Sclera," which are described by Professor Schieck, of Würzburg. Dr. Cramer, of Kottbus, contributes the part on the "Injuries and Occupational Diseases of the Eye," including the subject of "Compensation." "Sympathetic Diseases of the Eye" are treated by Professor Reis, of Bonn. "The Physiology and Pathology of Intra-Ocular Pressure and Glaucoma" are discussed by Professor Thiel, of Berlin.

The part on the conjunctiva, cornea and sclera occupies one half of the volume. Professor Schieck has treated this important part in a masterly way, presenting the essentials and omitting nothing of importance, with many new and excellent illustrations, often in colors, pertinent slit-lamp findings and a brief bibliography.

The second part on injuries and occupational diseases as they pertain to the eye was written by Dr. E. Cramer, of Kottbus, who unfortunately died in 1929; his nearly completed manuscript had to be revised and brought up to date by Dr. O. Thies, of Dessau. The subject is systematically treated and adequately illustrated, and a useful bibliography is appended. Burns and injuries by caustics are particularly well described and are evidence of the large experience gained by Dr. Thies in Dessau.

An important chapter deals with workmen's compensation, a subject that is rapidly becoming of practical importance in all countries.

That important and still obscure condition, sympathetic disease, is handled by Prof. W. Reis, of Bonn. After a description of sympathetic irritation, sympathetic ophthalmia is considered under the following headings: the conditions that lead to sympathetic inflammation, the clinical picture of sympathetic uveitis, sympathetic serous iritis, sympathetic papilloretinitis, retinal periphlebitis, retrobulbar neuritis, sympathetic chorioretinitis, detachment of the retina and secondary glaucoma. Pathology, etiology, diagnosis and treatment complete this unusually well written chapter.

Professor Thiel, writing on the physiology and pathology of ocular pressure, first speaks of the normal height and variations of intraocular pressure; then he takes up the relation of ocular pressure to intracranial pressure, local blood pressure, general blood pressure, the constitution of the blood, internal secretion and the vegetative nervous system. This is a most timely exposition of a subject that at present is arousing a great deal of interest, and a better exponent than Thiel could not have been found, as his researches have covered many parts of this field. An excellent bibliography will be of great use to those working in this subject.

The part on glaucoma, though originally written by Professor Kollner, of Würzburg, who unfortunately died before its completion, was then entrusted to Professor Thiel, who has revised and made additions, so as to bring the subject up to date. The chapters on diagnosis and treatment of the various forms of glaucoma are particularly instructive, and the author is to be complimented on having written the best monograph on glaucoma extant, as it is scientific, up to date and most complete in every way.

This fourth volume is a very important one in the handbook; its careful study will well repay the reader, and the authors, editors and publisher deserve praise.

A. K.

Modern Retinoscopy Including the Principles and Practice of Velono-Skiascopy. By Joseph I. Pascal, Boston. Price, $4. Pp. 279, with many iluustrations. London: Hatton Press, Ltd., 1930.

While most books on ophthalmology and refraction contain chapters on retinoscopy, this is the first book, we believe, to give a detailed description of all the more important retinoscopic methods.

There are twenty-five chapters. The first three are devoted to general considerations and the fundamentals of retinoscopy, and the last three, to a description of the velonoskiascopy of Trantas, as it has been perfected by Professor Lindner and the author. The balance of the book is devoted about equally to a description of static and dynamic retinoscopy.

The book is well written and is a valuable contribution to modern refractive methods. That part of the book, however, which is devoted to a description of Lindner's method of cylinder retinoscopy should be of special interest to ophthalmologists, because we believe that Lindner has demonstrated this to be the most accurate and satisfactory of all refractive methods, and this is the first clear and accurate description of this method in the English language.

Of less interest to ophthalmologists are dynamic retinoscopy (retinoscopy without paralysis of accommodation and while the patient is fixing a near object) and velonoskiascopy, which are described in the second half of the book. Although in the author's opinion dynamic retinoscopy is of very great value not only in determining the refraction of the eye, but also in determining the power of accommodation and the varying relations that exist between accommodation and convergence, ophthalmologists, as a rule, have not taken very kindly to this method of retinoscopy and will, therefore, probably be little interested in this part of the book. The same may be said of velonoskiascopy, which, although capable of producing very accurate results in some cases, is still in too great a degree subjective and requires the accurate and constant cooperation of the subject.

This book is well planned and readable and contains numerous appropriate illustrations. It is to be recommended to all refractionists who feel that they need to improve their refractive methods.

A. H. THOMASSON.

Studies in the Photo Activity and Therapy of the Tungsten-Titanium Arc. By J. Burdon Cooper and Arthur Roberts. Price, $3.50. Pp. 85. New York: William Wood & Company, 1931.

An eye that remained inflamed subsequent to a cataract extraction and which proved resistant to the usual forms of therapy was treated by radiation with light derived from a composite electrode of tungsten and titanium. The marked and unexpected improvement in the eye served as a stimulus for the authors to investigate various properties of the light derived from this source, and their experimental work and conclusions are set forth in this little volume.

Relying on photographic methods they studied the penetrating power of both luminous and ultraviolet rays, analyzed the light given off by the tungsten-titanium electrode and compared the penetrating power of light derived from this source with that of light derived from other sources. They established the penetrating power of ultraviolet rays and conclude that titanium is a valuable addition to tungsten as a source of such penetrating power. The bactericidal effects of the radiation were also examined, and here again ultraviolet rays about 3,800 or 4,000 angstrom units in length appear to be most important. The infra-red emission of the tungsten-titanium arc was also studied and was found to be high in erythema-producing and heat-producing rays.

In addition to the experimental portion of the book, there is a clinical section in which details of the authors' apparatus and mode of therapeutic procedure are given, together with a number of case histories illustrative of the results obtained in a variety of pathologic conditions.

O. P. PERKINS.

Ministry of the Interior, Egypt. Department of Public Health, Ophthalmic Section. Seventeenth Annual Report for the Ophthalmic Section, 1929. Price, 10 piasters. Pp. 42. Cairo, Egypt: Government Press, 1931.

No one can read this excellent report without distress at the appalling number of patients afflicted with ocular diseases in Egypt, nor can one begrudge admiration for the energy of the government in furthering the ocular health of its nationals. The amount of material is amazing. In 1929, over 4,000,000 patients were treated in the government hospitals, and over 195,000 operations were performed. That the relief measures are sound in concept is illustrated by the fact that 23 per cent of the outpatients were under 10 years of age; that the program is effective is indicated by the statement that blindness has been halved since 1909.

If the report has a fault, it lies in careless proof-reading. An occasional lapse in spelling may be forgiven, especially since English is not the national tongue, but it is impossible to condone the repeated misspelling of the same words. Furthermore, it is difficult to preserve a scientific gravity on finding that microphthalmos is referred to as "rudimentary gloves," or on finding that horns have been editorially affixed to the domestic sow.

Taken as a whole, however, the meaning is usually clear, and the report should be read in its entirety.

G. M. BRUCE.

Die Erkrankungen des Uvealtraktus. By Prof. W. Gilbert, Hamburg. Second edition. Price, 59.60 marks. Pp. 240, with 77 illustrations. Berlin: Julius Springer, 1931.

This continuation of Gilbert's chapter on "Uveal Diseases" in Graefe-Saemisch's "Handbuch der gesamten Augenheilkunde" presents: The changes in the iris and ciliary body with age, diabetic iritis, cysts and tumors of the iris and of the ciliary body, epithelial invagination of the intra-ocular cavities and choroiditis. Bacterial metastasis is more active in choroiditis than in iridocyclitis, while "focal" infection is not so prominent an etiologic factor in choroiditis as it is in iritis. Choroidal lesions are principally due to tuberculosis, syphilis or lepra. Disseminate choroiditis in the author's statistics is tuberculous in 70 per cent of cases, syphilitic in 8 per cent and unknown in 22 per cent. Choroiditis juxtapapillaris (Jensen) is generally tuberculous. Tuberculous choroiditis belongs in the second stage of general tuberculosis, according to Rancke's classification. In the determination of an ocular tuberculous process, roentgen examination of the chest is imperative.

A full description of tuberculous and syphilitic choroiditis with excellent colored illustrations concludes this part.

A. K.

Das Werk von Prof. Dr. Otto Haab. By Dr. Jacob Streiff, Genoa. Price, 2.50 francs. Pp. 23. Basel: Schwabe & Company, 1931.

To celebrate his eightieth birthday, an appreciative review of Professor Haab's life and manifold achievements was written by a former assistant, Dr. J. Streiff, of Genoa. This memoir is most timely as Professor Haab's death has just been announced. It traces Haab's development from his start as assistant to Horner to the stage when as professor of ophthalmology in Zurich he occupied for many years the leading position in Switzerland. It also gives a list of his contributions to ophthalmology, which as the author well states are an important part of the history of ophthalmology in the last fifty years.

This sympathetic and affectionate tribute will be read with pleasure by Professor Haab's many admirers and friends in this country.

A. K.

Stereoskopischer Atlas der äusseren Erkrankungen des Auges. By Prof. K. Wessely. Part III. Price, 12 marks. Munich: J. F. Bergmann, 1931.

Excellent stereoscopic photographs in color illustrate: senile ectropion, pemphigus, epithelioma of the conjunctiva, interstitial keratitis, orbital periostitis, lipodermoid, polycoria, panophthalmitis, congenital buphthalmos and sarcoma of the choroid that had broken through.

The pictures maintain the excellence set by the previous parts, and the brief clinical description in German, English and French adds to their usefulness.

A. K.

Directory of Ophthalmologic Societies *

FOREIGN

British Medical Association, Section on Ophthalmology

President: Sir J. Herbert Parsons, 54 Queen Anne St., Cavendish Square, London, W. I.
Place: London. Time: July 27-29, 1932.

Oxford Ophthalmological Congress

Master: Dr. Cyril Walker, Bristol, England.
Secretary: Dr. C. G. Russ-Wood, 12 St. John's Hill, Shrewsbury, England.
Place: Oxford. Time: July 7-9, 1932.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris 7è.
Place: Paris. Time: July 17-21, 1932.

German Ophthalmological Society

Secretary: Prof. A. Wagenmann, Heidelberg.
Place: Leipzig. Time: May 19-21, 1932.

International Ophthalmologic Congress

Secretary: Dr. E. Marx, Rotterdam, Holland.
Place: Madrid, Spain. Time: 1933.

NATIONAL

American Medical Association, Section on Ophthalmology

Chairman: Dr. Harry Friedenwald, 1212 Eutaw Pl., Baltimore.
Secretary: Dr. Parker Heath, 1551 Woodward Ave., Detroit.
Place: New Orleans. Time: May 11-13, 1932.

American Academy of Ophthalmology and Oto-Laryngology

President: Dr. S. Hanford McKee, 1528 Crescent St., Montreal, Canada.
President-Elect: Dr. B. R. Shurley, 62 W. Adams Ave., Detroit.
Executive Secretary: Dr. William P. Wherry, Medical Arts Bldg., Omaha.
Place: Montreal, Canada. Time: September 19, 1932.

American Ophthalmological Society

President: Dr. Edward C. Ellett, 130 Madison Ave., Memphis, Tenn.
Secretary: Dr. Emory Hill, Professional Bldg., Richmond, Va.
Place: New London, Conn. Time: June 27-29, 1932.

SECTIONAL

New England Ophthalmological Society

President: Dr. S. Judd Beach, 704 Congress St., Portland, Maine.
Secretary-Treasurer: Dr. E. B. Dunphy, 520 Commonwealth Ave., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. W. F. Hoffman, 317 Summit Ave., Seattle.
Secretary-Treasurer: Dr. Frank Friesen, 727 W. Seventh St., Los Angeles.
Place: Seattle. Time: June 30-July 2, 1932.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Albert E. Hillis, 1115 Pacific Ave., Seattle.
Secretary-Treasurer: Dr. Francis A. Brugman, 806 Cobb Bldg., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. John B. Gregg, 101 S. Main St., Sioux Falls, S. Dakota.
Secretary-Treasurer: Dr. F. H. Roost, 420 Trimble Bldg., Sioux City, Iowa.
Place: Sioux City, Iowa. Time: November, 1932.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Wiley R. Buffington, 211 Camp St., New Orleans.
Secretary: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Place: Birmingham, Ala. Time: November, 1932.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. C. Ward Ellis, 215 N. Walnut St., Lansing.
Secretary: Dr. H. B. Weinburgh, 301 Seymour St., Lansing.
Time: Third Thursday of alternate months.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternatelv until all members have served.
Secretary: Dr. Ralph W. Danielson, 258 Metropolitan Bldg., Denver.
Place: Capitol Life Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. M. H. Merriman, 115 Prospect St., Waterbury.
Secretary-Treasurer: Dr. Walter L. Hogan, 750 Main St., Hartford.
Time: May, November.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. W. L. McDougall, 50 Whitehall St., S. W., Atlanta.
Secretary-Treasurer: Dr. W. O. Martin, Jr., 412 Medical Arts Bldg., Atlanta.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President Dr. J. R. Gillum, 221 S. Sixth St., Terre Haute.
Secretary: Dr. J. Kent Leasure, 23 E. Ohio St., Indianapolis.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Gordon F. Harkness, 215 Main St., Davenport.
Secretary-Treasurer: Dr. W. F. Boiler, 105 E. Iowa Ave., Iowa City.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Wilfred Haughey, 303 Post Bldg., Battle Creek.
Secretary: Dr. H. O. Westervelt, 239 Pipestone St., Benton Harbor.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Douglas F. Wood, 74 S. Ninth St., Minneapolis.
Secretary-Treasurer: Dr. Walter E. Camp, Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. L. H. Huber, Livingston.
Secretary: Dr. A. W. Morse, Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. H. L. Harley, 101 S. Indiana Ave., Atlantic City.
Secretary: Dr. B. E. Failing, 31 Lincoln Park, Newark.
Place: Atlantic City. Time: June 7-10, 1932.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. R. T. Atkins, 4 W. Fifty-Third St., New York.
Secretary: Dr. D. F. Gillette, 109 S. Warren St., Syracuse.
Place: Buffalo. Time: May 23-24, 1932.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. F. L. Wicks, Valley City.
Secretary-Treasurer: Dr. W. L. Diven, National Bank Bldg., Bismarck.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. M. Hendershott, 193 Eleventh St., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. Frank W. Dimmitt, 195 Thayer St., Providence.
Secretary: Dr. N. A. Bolotow, 108 Waterman St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. W. D. Jones, 3116 Live Oak St., Dallas, Texas.
Secretary: Dr. A. F. Clark, 1034 Nix Professional Bldg., San Antonio.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. D. W. Henderson, 75 S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. T. F. Welch, 14 Exchange Pl., Salt Lake City.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. C. P. Jones, Newport News.
Secretary-Treasurer: Dr. H. G. Preston, 307 Professional Bldg., Harrisonburg.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. G. A. Smith, Montgomery.
Secretary: Dr. O. H. Bobbitt, Medical Arts Bldg., Charleston.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Charles W. Buvinger, 50 Washington St., East Orange.
Secretary: Dr. Earl LeRoy Wood, 192 Roseville Ave., Newark.
Place: 91 Lincoln Park South. Time: 8:45 p. m., second Monday of each month.

ACADEMY OF MEDICINE OF TORONTO, SECTION OF OPHTHALMOLOGY

Chairman: Dr. P. J. F. Houston, 34 Hurndale Ave., Toronto.
Secretary: Dr. Alexander E. MacDonald, 151 Bloor St., W., Toronto.
Time: First Monday of winter months.

ATLANTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. John R. Childs, 45 Edgewood Ave., Atlanta, Ga.
Secretary: Dr. William O. Martin, Jr., Medical Arts Bldg., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St., N. E. Time: 8 p. m., last Thursday of each month.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Alan C. Woods, 906 Cathedral St., Baltimore.
Secretary: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. John N. Evans, 23 Shermerhorn St., Brooklyn.
Secretary: Dr. John Michael J. Buonaguro, 589 Lorimer St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. Joseph C. O'Gorman, 1324 Jefferson Ave., Buffalo.
Secretary-Treasurer: Dr. Thurber Le-Win, 112 Linwood Ave., Buffalo.

Chicago Ophthalmological Society

President: Dr. Frank E. Brawley, 30 N. Michigan Ave., Chicago.
Secretary: Dr. Richard C. Gamble, 30 N. Michigan Ave., Chicago.
Place: Medical and Dental Arts Club. Time: Third Monday of each month from October to May.

Cleveland Academy of Medicine, Section of Ophthalmology and Oto-Laryngology

Chairman: M. W. Jacoby, 2323 Prospect Ave., Cleveland.
Secretary: Dr. H. C. Rosenberger, 1065 Rose Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. Roy B. Metz, Hanna Bldg., Cleveland.
Secretary: Dr. Paul G. Moore, Medical Arts Bldg., Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. L. F. Appleman, 308 S. Sixteenth St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. Ivor Clark, 188 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. Francis W. Thomas, 327 E. State St., Columbus, Ohio.
Time: First Monday of each month.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. L. M. Sellers, 717 Pacific Ave., Dallas, Texas.
Executive Secretary: Dr. W. Mood Knowles, 717 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. Cecil C. Jones, 1121 Equitable Bldg., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month, September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Parker Heath, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. F. M. Sulzman, 1831 Fifth Ave., Troy.
Secretary-Treasurer: Dr. Arthur F. Holding, 142 Washington Ave., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. R. H. Needham, 1304 Medical Arts Bldg., Fort Worth, Texas.
Secretary-Treasurer: Dr. Van D. Rathgeber, 1011 Medical Arts Bldg., Fort Worth.
Place: University Club. Time: 6:30 p. m., first Friday of each month except July and August.

Grand Rapids Eye, Ear, Nose and Throat Society

President: Dr. Carl F. Snapp, 26 Sheldon Ave., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Walter W. Oliver, 26 Sheldon Ave., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. L. W. Raney, 609 Fannin St., Houston, Texas.
Secretary: Dr. J. F. Gamble, 201 Main St., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., first Thursday of each month from September to June.

Indianapolis Ophthalmological and Oto-Laryngological Society

President: Dr. B. J. Larkin, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, Hume-Mansur Bldg., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. W. E. Keith, 1103 Grand Ave., Kansas City, Mo.
Secretary: Dr. O. S. Gilliland, Professional Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

President: Dr. R. R. Montgomery, 102 Pine Ave., Long Beach, Calif.
Secretary-Treasurer: Dr. Russell T. Uhls, 823 Security Bldg., Long Beach, Calif.
Place: Pacific Coast Club. Time: Last Wednesday of each month from September to June.

Los Angeles County Medical Society, Section on Ophthalmology and Oto-Laryngology

President: Dr. Eugene R. Lewis, 727 W. Seventh St., Los Angeles.
Secretary-Treasurer: Dr. J. Frank Friesen, 727 W. Seventh St., Los Angeles.
Place: California Lutheran Hospital, Assembly Room. Time: 8 p. m., first Monday of each month from October to May, inclusive.

Medical Society of the District of Columbia, Section of Ophthalmology and Oto-Laryngology

Chairman: Dr. James A. Flynn, 1511 Rhode Island Ave., Washington.
Secretary: Dr. E. R. Gookin, Medical Science Bldg., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month.

Memphis Society of Ophthalmology and Oto-Laryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, Exchange Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

Milwaukee Oto-Ophthalmic Society

President: Dr. T. F. McCormick, 324 Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. O. P. Schoofs, 324 E. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., third Tuesday of each month.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Hilliard Wood, 700 Church St., Nashville, Tenn.
Secretary-Treasurer: Dr. H. C. Smith, Medical Arts Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month.

New Orleans Ophthalmological and Otological Society

President: Dr. W. R. Buffington, 211 Camp St., New Orleans.
Secretary-Treasurer: Dr. M. F. Meyer, Canal Bank Bldg., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
Secretary: Dr. Algernon B. Reese, 73 E. Seventy-First St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. William P. Haney, 107 S. Seventeenth St., Omaha.
Vice President: Dr. L. G. Howard, 532 First Ave., Council Bluffs, Iowa.
Secretary-Treasurer: Dr. W. A. Cassidy, 1620 Medical Arts Bldg., Omaha.
Place: University Club, 1914 Harney St., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Edward B. Heckel, Jenkins Arcade Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Pittsburgh Slit-Lamp Society

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of every month, except June, July, August and September.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. Emanuel U. Wallerstein, Professional Bldg., Richmond, Va.
Secretary: Dr. William R. Weisiger, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

Rochester Eye, Ear, Nose and Throat Society

Chairman: Dr. E. S. Amsler, 53 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. E. W. O'Brien, 5 N. Goodman St., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

St. Louis Ophthalmic Society

President: Dr. Martin H. Post, 508 N. Grand Blvd., St. Louis.
Secretary: Dr. Carl T. Eber, 1006 Carleton Bldg., St. Louis.
Place: St. Louis or Washington University Cafeteria.
Time: 6:30 p. m., fourth Friday of each month from October to April, inclusive.

San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. Scott C. Applewhite, 705 E. Houston St., San Antonio, Texas.
Secretary-Treasurer: Dr. E. D. Dumas, 425 Medical Arts Bldg., San Antonio.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. W. F. Swett, 490 Post St., San Francisco.
Secretary: Dr. Robert C. Martin, 384 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Third Tuesday of every month except May, June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. Claude L. La Rue, Highland Clinic, Shreveport, La.
Secretary-Treasurer: Dr. W. L. Atkins, 505 Medical Bldg., Shreveport, La.
Place: 1240 Texas Ave. Time: 7:30 p. m., first Monday of each month from October to June.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. Paul A. Remington, Old National Bank Bldg., Spokane, Wash.
Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. M. G. Brown, 713 E. Genesee St., Syracuse, N. Y.
Secretary-Treasurer: Dr. A. Harry Rubenstein, Medical Arts Bldg., Syracuse, N. Y.
Place: University Club. Time: Second Friday of each month except June, July and August.

Tulsa Academy of Ophthalmology and Otolaryngology

President: Dr. Roy Dunlap, 108 W. Sixth St., Tulsa, Okla.
Secretary-Treasurer: Dr. Marvin D. Henley, 108 W. Sixth St., Tulsa, Okla.
Place: Medical Arts Bldg. Time: Monthly.